EDITORIAL

ALTHOUGH the year is by no means over, the number of people maimed and killed on Australian roads has already reached alarming proportions. Every day the number grows larger — and more tragic.

Unfortunately numbers and statistics don't have much impact on most of us and even the stories and pictures which appear almost daily in the Press, have only passing effect. They always refer to "the other fellow," whose misfortune is soon forgotten amidst the pressure of — to us — more urgent matters.

Here, in hospital, one very rapidly acquires a different view of things. Figures and statistics come to life. "The other fellow" turns up in the ward nearby and you see the aftermath of his accident at first hand — the suffering, the fight for life and limb, the plight of his family and, often, the psychological adjustment that has to be made because of some permanent injury.

And, as you hear his story, you quickly realise something else. He's "the other fellow" all right but it could as easily have been your injury, your family, your problem. His actions were no different from your own except that, on this occasion, they didn't come off.

No one can drive on the roads today in a manner which will guarantee freedom from accidents but we can all resist the compelling urge to save the minute that will lose a year — or a life.

I've been impressed, too, by another thing — the number of injuries which result from the careless use of power tools. Once these were handled only by tradesmen but now, it seems, every second handyman has access to them.

And what a difference they make to the ease and finish of the work! There's a sense of satisfaction as the chips and sawdust fly.

But a moment of inattention and the whirling saw has taken off a couple of fingers. The grinding wheel, loose on its spindle or cracked from careless handling, becomes a deadly missile to smash a hand or pierce an eye.

Imagination? Not a bit of it! These remarks, which may seem a trifle morbid, have been inspired by "the other fellows" I have met in recent weeks — motorists, tradesmen, handymen. As one, they have come to regret the moment when the precaution that was overlooked, the protective goggles still hanging over the nail in the wall. Or perhaps, near home, the electrical wiring that was done in temporary fashion!

In short, as a motorist, a "handyman" and a worker in the field of electricity and radio, I've come to have a new respect for the time-worn phrase, "safety first." If my remarks cause readers to think likewise, their purpose will have been served.

W. Williams

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RADIO ★★ TELEVISION AND HOBBIES

A NATIONAL MAGAZINE OF RADIO, TELEVISION HOBBIES AND POPULAR SCIENCE

EDITOR
NEVILLE WILLIAMS
M.I.R.E. (Aust.) (VK2XV)

TECHNICAL EDITOR
PHILIP WATSON
A.M.I.R.E. (Aust.)

TECHNICAL STAFF
JOHN BARKER
WES YASHIN
BRIAN CLEAVES
JAMIESON ROWE
MERVYN HUDDLESTON

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OUR COVER PICTURE

Space travel is rapidly moving from the realm of fiction to world of cold hard fact. So why not a little fantasy while there is still time? So thought John Curtis of Surrey (England) who created this intriguing table top picture using only a couple of plastic figures, a table tennis ball, some cotton wool, and sea shell.

Worth looking into . . .

Here are the reasons why I.R.C. Type "Q" Miniature Controls have achieved the highest reputation for silent performance and long life.

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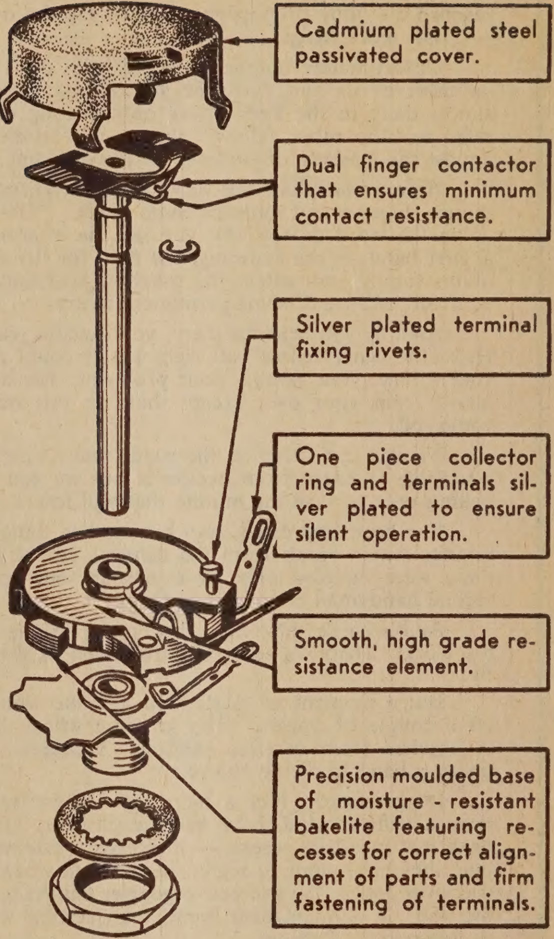
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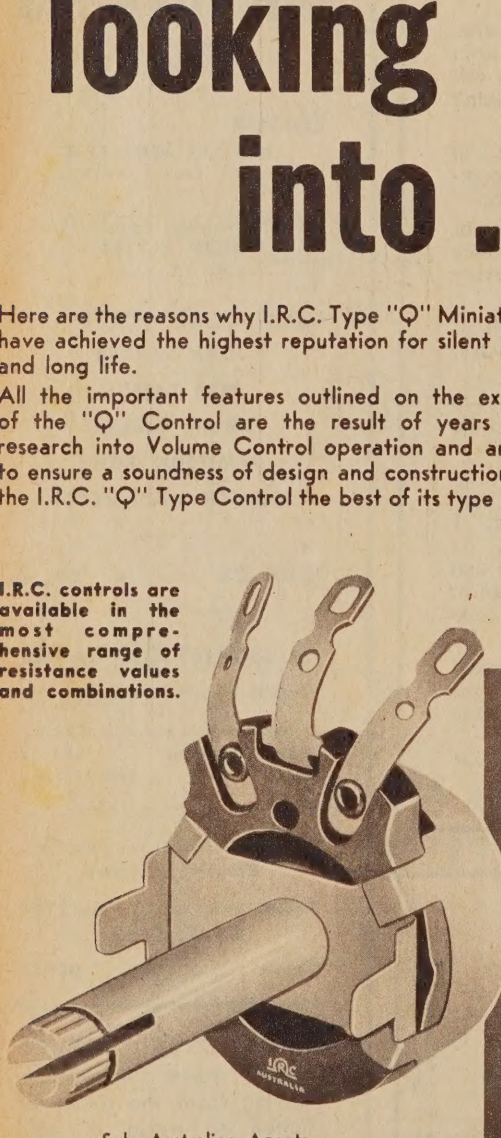
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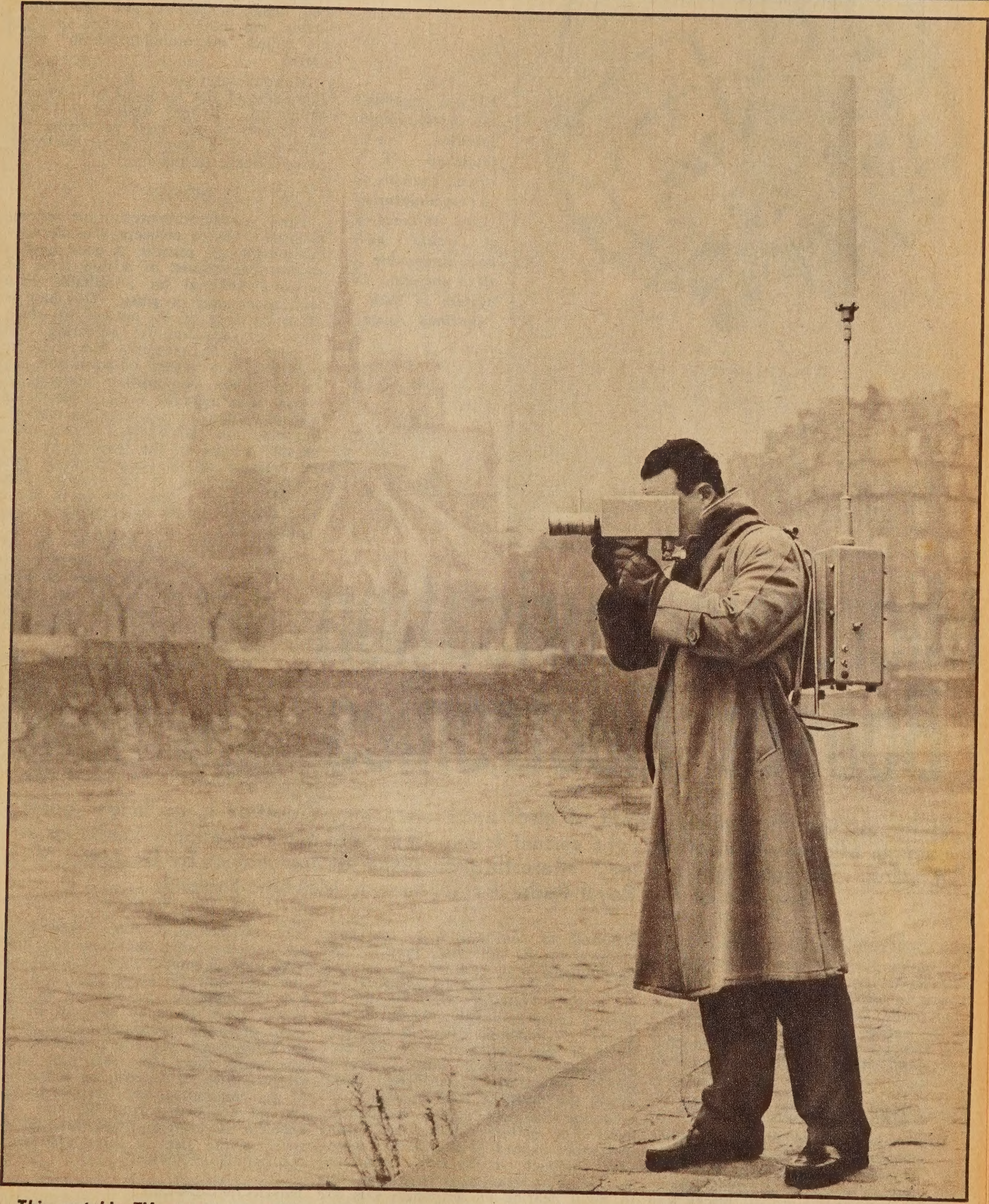
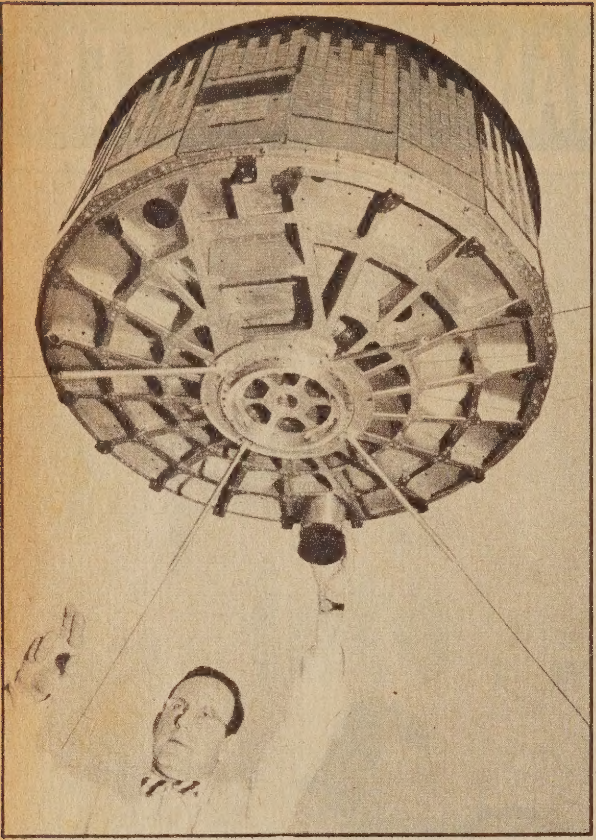
COMPLETE "ONE-MAN" TV SYSTEM



This portable TV camera-transmitter system made by Compagnie Generale de Telegraphie Sans Fil of Paris is what the well-dressed TV cameraman will be wearing this season. Completely self contained, it can transmit top quality pictures over distances of a mile or more in favourable circumstances, and operate in places where no OB van could ever hope to reach. Already being used by several American TV stations, it may soon form part of the Australian scene a unit at present being demonstrated to Australian TV stations. See story page 9.



Tiros, probably the most complex satellite ever launched, is a classic example of microminiaturisation. Without it, it would have been impossible to fit a complete TV system in such a confined space.

Microminiaturisation Boosts Electronics

In the increasingly complex world of electronics mere miniaturisation is no longer good enough. Microminiaturisation is the current trend—a form of miniaturisation in miniature as it were. The following is a most interesting discussion of the subject by Dr James W. Granville of the Royal Radar Establishment, Malvern, England.

ELECTRONICS is the science of combining various radio components to perform a required function. For instance, a wireless receiver takes the small radio frequency signals picked up in the aerial, amplifies them, sorts out the audio frequency signals, amplifies these and delivers them into a loudspeaker.

NETWORK OF COMPONENTS

This transformation is made possible by connecting in the correct way resistors, capacitors, chokes, transformers and thermionic valves or transistors.

Radio components are the bricks with which electronic engineers build, and their importance is amply stressed by the ever-increasing applications of electronics to every phase of modern civilisation.

With the development of electronic systems of increasing complexity — a computer for example has tens of thousands of components — the space occupied by the equipment may become prohibitively large. To take an extreme case, it is evident that the electronics in an artificial satellite must occupy as small a space as possible. Thus, modern trends in component design are concentrated on size reduction. One has only to compare a prewar wireless receiver with a present-day transistorised model to see the result of this research.

During the past decade components have been getting smaller, and, using transistors instead of thermionic valves, very compact circuits have been constructed. For instance, it is now possible to build hearing-aid amplifiers that are contained within spectacle frames. Yet there is a limit to the size reduction that is possible; beyond a certain stage the components become so difficult to manufacture that their reliability is reduced. Reliability is even more important than size, for there is no advantage in having a very small electronic apparatus if it is always breaking down because of failure of one component or another. Thus, if reliability is to be maintained while size is further reduced, new techniques of circuit construction must be adopted.

Systematic investigations of the problem have been started during the past two years in Britain and the United States, and these have resulted in what are called "microminiaturisation" techniques.

Microminiaturisation is the ultimate expression of size reduction of electronic equipment. It may well be that with its advent we are now witnessing the beginning of a revolution in electronic constructional techniques.

HOW IS IT DONE?

How is microminiaturisation accomplished? Let us consider that familiar component, the resistor. A good quality resistor can consist of a thin track of resistive material on a suitable base such as ceramic or glass. This base is often the case of the resistor to which wires are attached for soldering into a circuit. The resistive film may be produced in a variety of ways and can be a carbon composition material, a metal or a metallic oxide. Whichever method is used, it is always the supporting base material which occupies most of the volume of the resistor; in fact, the volume of the case may be 500 times the volume of the resistive film. Clearly, then, a great saving in space would result if the case could be dispensed with.

A similar argument can be applied to a capacitor, which is essentially an insulating layer between two metal electrodes. The structure has to be supported and put in a case which may be several hundred times its volume.

And, although a transistor may seem very small compared with a thermionic valve, most of its volume is occupied by the metal case. The semiconductor element is very small indeed. For instance, the active element of a radio-type transistor may occupy a volume of only 10 cubic millimetres or less. Likewise, the active element of a semi-conductor diode is very much smaller than its metal case.

It will now be appreciated that one way of reducing the size of an electronic assembly is to get rid of the cases of the components. This is not a straightforward procedure because the cases are there for two very good reasons: first, to support the active part of the component, and, second, to protect the active part from damage. The problem has been solved in three distinct ways, giving rise to three systems of microminiaturisation.

MICROMODULES

The system which is most advanced in production is the **micromodule** method developed by the Radio Corporation of America under contract from the United States Government. In essentials a micromodule is a stack of small wafers, each wafer carrying one or perhaps two active elements—resistors or capacitors. Transistors and semiconductor diodes are encapsulated in specially designed flat cases, each of which is an integral part of a wafer. The wafer, which is only 0.31 x 0.31 inch in area and about 0.020 inch thick, has metallised notches which make soldered contact to a cage of 12 riser wires as shown in Figure 1A. Some typical wafers are shown in Figure 1B.

TYPICAL COMPONENTS & STACK

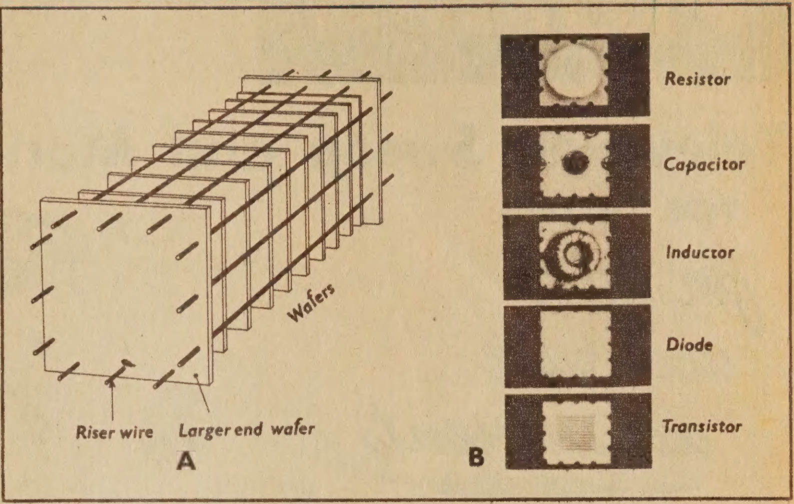


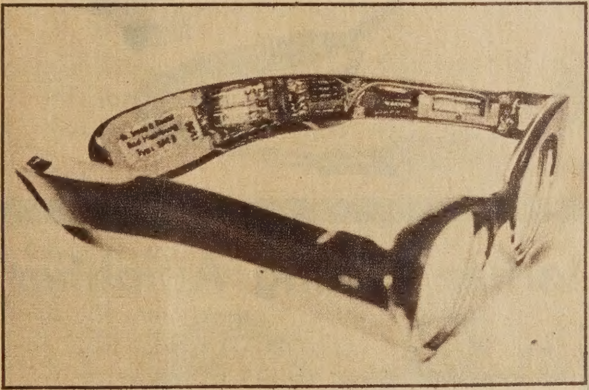
Figure 1. (A) is a schematic drawing of a micromodule before sealing, showing the manner in which the wafers are assembled. (B) shows a number of typical wafers currently used in this application.

INDUCTOR PROBLEM

Inductors—such as the coils in a radio receiver—cannot be made in flat form, and at present they consist of very small ring-shaped windings attached to the wafers. Usually a circuit stage of between 10 and 20 wafers comprises each micromodule, which is protected by a hard-setting resin. Various micromodules are connected together to form a complete circuit. As an illustration of the tremendous packing density which is possible, a radio receiver has been made to fit into a fountain pen.

Instead of putting each component element on its own wafer it is possible to make several interconnected components on a single wafer, and thereby make each wafer have a complete circuit function. This approach is known as microcircuitry, or the two-dimensional concept, and was initially developed by the Diamond Ordnance Fuse Laboratories in the United States. It is now being extensively studied in Britain.

Figure 2 is a schematic diagram of a typical microcircuit. The components are laid on one or both sides of a ceramic or glass sheet, the size of which depends on the circuit's function. Typically, the sheet is 0.5 inch square and 0.030 inch thick. The resistors and capacitors may take several forms: for instance, a resistor can be a thin film of nickel-chromium alloy deposited by vacuum evaporation. A capacitor may consist of a thin plate of ceramic having metal electrodes top and bottom and set in a recess in the main sheet. Transistors and diodes are made by placing suitably protected active semi-conductor elements in holes in the sheet.



A more homely, but equally vital, application, is shown here — a hearing aid in a spectacle ear-piece. The next step, already envisaged, is an aid completely contained within the ear passage.

INTERCONNECTION

The various components are connected together electrically by low-resistance thin films of metal deposited on the sheet surface. Connections to the circuit are made by wires attached to the glass or ceramic sheet. Each plate consists of a circuit stage, and several are stacked together and suitably connected to form the complete equipment. Like micromodules, microcircuits can be protected by a hard-setting resin.

The last and most complex microminiaturisation system is the solid circuit or three - dimensional concept. Transistors and diodes are made from the semiconductors germanium or silicon. But it is also possible to make resistors or capacitors in these materials. A bar of semiconductor is a resistor; a diode with a potential applied in its high resistance direction is a capacitor. Hence, it is a logical step to try making all these components in a single piece of semiconductor, so that they are automatically connected together electrically and physically.

The idea of solid circuits was first suggested in Britain, but was initially developed in the United States by Texas Instruments Inc. Figure 3 is a schematic design of a multivibrator or square wave generator made with a germanium bar of dimensions only 0.20 x 0.10 x 0.25 inch. In this example some parts of the bar are connected by fine wires and there is a channel (cut with an ultrasonic tool) to isolate part of the bar electrically.

SOLID STATE PHYSICS

A more complete description of this solid circuit would involve a study of solid state physics. Indeed, it is precisely because the operation of such a circuit does depend on solid state phenomena that makes this microminiaturisation system so attractive, for, with the impetus imposed by transistor technology, a great deal of research is being devoted to solid state physics all over the world, and it is likely that many of the resulting discoveries will be used in solid circuit techniques.

It may be asked: Why is work being done on three microminiaturisation systems? Why not select the best one and concentrate on that? The answer is that each system has its advantages and disadvantages, and it is hard to choose between them. For instance, micromodule wafer components can be individually tested before assembly into a micromodule circuit, whereas microcircuits and solid circuits cannot be tested until the whole circuit of many components is fabricated.

This could affect the economics of manufacture, as the overall rejection rate is likely to be higher where individual components cannot be tested. However,

(Continued on Page 121)

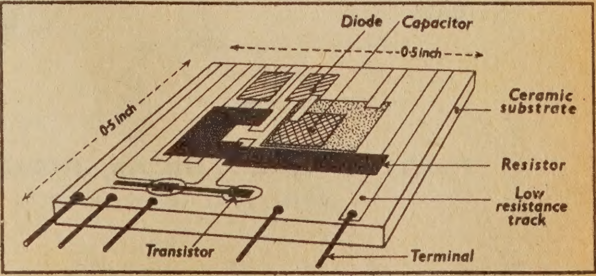


Fig. 2. An example of the microcircuit technique. A number of components mounted on a single wafer, representing a complete circuit function.

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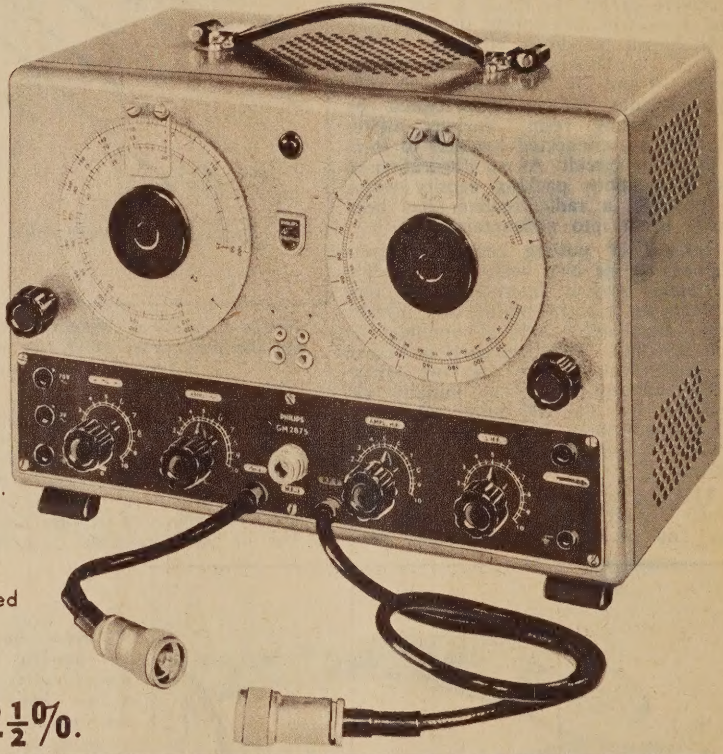
for fast accurate alignment



FEATURES

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- Internal 50 cycle frequency modulation.
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TYPE GM 2876

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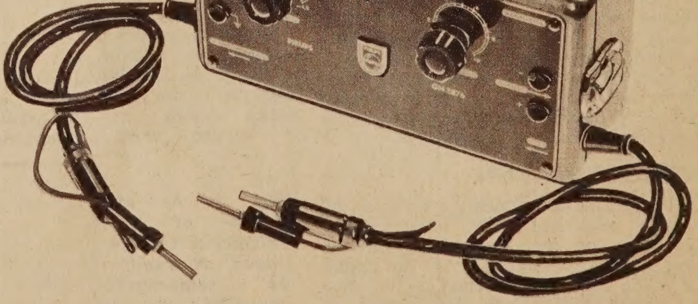

The combination of the GM 2876 with the GM 2875 Sweep and Marker Generator permits an amplification of the frequency marker the size of which is independent of its position on the frequency response curve.

FEATURES

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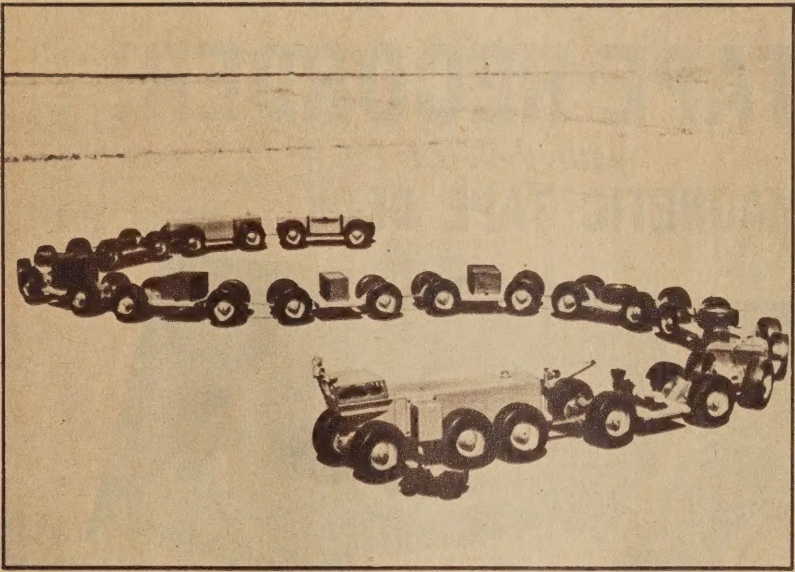
ROAD TRAIN TRANSPORT SYSTEM



A scale model of the road train described here. Note the relative size of the scale model jeep. Main secret of the system is the coupling system which enables complicated manoeuvres like this "S" turn to be performed without any tendency for the train to "straighten out."

Is the day near when we shall see "trains" taking to the roads, equally at home snaking through villages, winding over forest paths, or blazing new trails over desert lands? The thought springs to mind when we learn that a 13-unit "overland train," initially planned for military use, is now in production in Texas.

BUT — what a train!

Every rubber-tyred wheel—claimed to be the largest in the world—is 10ft high and 4ft wide. Every wheel, of which there are 54, has its own independent drive with enormous power behind it. The entire train of 13 units is 560ft long—well over a tenth of a mile!

It's not surprising, then, that a train so equipped should be able to overcome almost any obstacle in rough territory, even when drawing its full load of 150 tons.

FINGERTIP CONTROL

And one man can operate it over the trickiest terrain, using finger-flick control!

Before this unorthodox and powerful overland train was planned, however, a smaller 4-unit train was rigorously and successfully tested by the U.S. Army Transportation Corps in 1956 on the Greenland ice-cap and elsewhere.

Known as the Tourneau train, this unusual vehicle proved its versatility as a cargo-hauling "train" under the most exceptionally adverse conditions. But why restrict such a vehicle to four units? Why not have eight, or 12—or more?

So the 13-unit overland train was designed. This consists of a lead control car, two power cars and 10 4-wheel cargo cars. Four gas turbine engines of new design operate the generators which in turn provide electric power for the wheels, steering and other electrical accessories.

Secret of the overland train's incredible power lies in the independent drive wheels, each one of which has a high-torque electric motor geared directly to its rim, the power being received through flexible electric cables connected with the generators.

Since each wheel is "shod" with enormous tubeless tyres (10ft high and 4ft wide, remember) built for shock resistance and high flotation, the overland train will be able to operate over virtually every kind of terrain.

Let us imagine we are privileged to watch the overland train as it starts a long journey, with every car loaded to maximum. The crew, consisting of the driver, an assistant driver-navigator and a radio operator, clamber aboard the control car. While the driver seats himself at an electric console, the others take up their navigating and radio positions.

The signal to move off is given. With surprising lack of noise (there's just a steady, growing "hum"), the overland train moves off, with each car tracking automatically behind the one in front.

At the console, the driver operates a simple finger-tip switch (not a wheel) which he flips to right or left according to the desired turning direction. Steering with this switch may seem odd, but it is claimed that control is perfect, especially as the control car is power steered.

ROOM FOR SIX

As the train vanishes, one might wonder how and where the crew will spend the night. The answer is—very comfortably, in the control car! This is equipped to provide sleeping and eating accommodation for six men (i.e., crew plus three relief men).

It also houses all the controls for the entire train, as well as complete communication and navigation systems. When necessary, the control car can be used by itself or with one car attached, the necessary power being provided by a small auxiliary generating plant which is also located in this car.

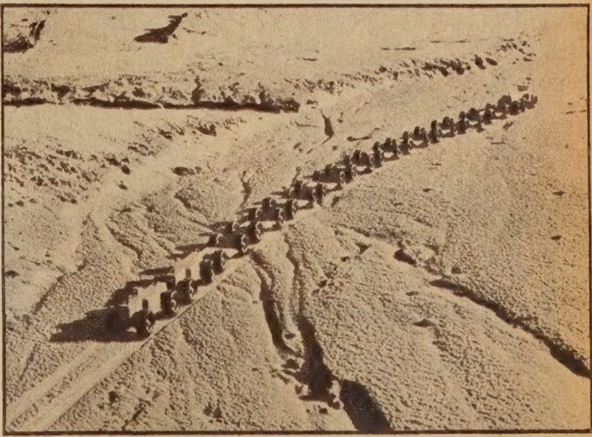
As noted, this multi-unit carrier is initially intended for military use, being designed to carry all kinds of equipment and cargo over terrain where routes are long, fuel supplies limited, and roads rough or perhaps even nonexistent.

Yet it is easy to glimpse a wider and more productive use for this powerful vehicle, especially in undeveloped regions where transport on a large scale is needed to exploit the natural resources of the area.

☆

Another model set-up showing how the train would appear crossing barren desert wastes. This is the type of terrain in which the system would be most valuable.

☆



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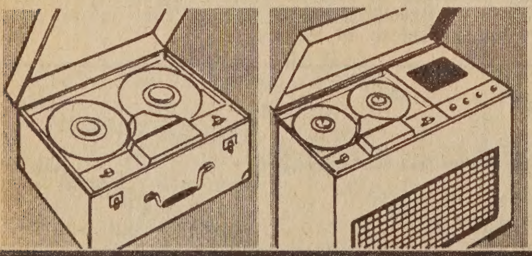

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● **Tape speed,** 3¾ second ● **Size of reels,** 5¾" diameter (1200 ft. of tape) ● **Heads,** half track ● **Tracking,** top track, left to right (International Standard) ● **Playing Time,** 2 hours (1 hour per track) ● **Re-wind time,** 3 mins. 50 secs. for 1200 ft. ● **Fast-forward time,** 3 mins. 50 secs. for 1200 ft. ● **Brakes,** spring loaded, differentially applied ● **Record/playback head,** narrow-gap type (0.0002"). Impedances: 2800 ohms at 1000 c/s. 2300 ohms at 5000 c/s. 5800 ohms at 50 Kc/s ● **Erase head,** double-gap type (0.005"). Impedance: 140 ohms at 50 Kc/s ● **Output on playback,** approx. 30 mv. for average programme ● **Recommended frequency of supersonic oscillator,** 50 Kc/s ● **Power required for full erase,** 0.4 watt (approx.) ● **Supersonic voltage level for recording,** bias level/maximum signal level = 250/1 ● **Bass boost on playback,** approx. 30 db between 50 and 100 c/s ● **Treble boost on playback,** start at 3 Kc/s, rising to 20 db boost at 7.5 Kc/s ● **Overall response obtainable,** 30 to 8000 c/s + 3 db ● **Wow and Flutter,** 0.4% r.m.s. ● **Power consumption,** approx. 10 watts. ● **Dimensions,** 13" long, 8¾" wide, 4½" deep ● **Weight,** 6 lbs. 8 ozs.

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COMPLETE TV SYSTEM IN A PACK

One of the most intriguing TV systems yet seen in Australia was demonstrated recently at a N.S.W. Division meeting of the Television Society of Australia. Consisting of a TV camera and transmitter, the whole system is so compact that it can be carried by one man. It may well be the forerunner of a number of such units in this country.

THE equipment is from the Compagnie General de Telegraphie Sans Fil (C.S.F.) of France and was brought to Australia by their agents, Jacoby, Mitchell and Co. Pty. Ltd., for loan and demonstration to local TV stations. The demonstration and lecture were given by Mr D. Andrew, senior engineer, ABN, Channel 2. The pictures and much of the data on which this article is based were kindly supplied by Jacoby Mitchell and Co.

A classic example of the value of the miniature TV camera-transmitter. Comfortably housed in a helicopter (a new French experimental jet version, by the way) it produced some unique shots at a recent French air pageant. Note the aerial in the bottom left hand corner.

CAMERA DETAILS

Known officially as the CP 102, the equipment comprises a small TV camera, plus a pack type case which houses all the ancillary camera circuitry and a complete TV transmitter.

The camera measures 7.5in long, 3.15in wide and about 5.5in high. With handle the total height is 11in, and the handle is threaded to permit attachment to a tripod when desired. Weight, without lens, is 3.75lb.

The optical system uses standard 16mm movie lenses in conjunction with a Vidicon camera tube. A wide range of lenses may be employed, including a "zoom" lens, the latter being fitted with a reflex focusing system. The other lenses employ a simple focusing scale. Except where lighting conditions are very bad, the zoom lens is normally employed.

Electrically, the camera contains the Vidicon tube, focus and deflection assembly, and a video preamplifier. The latter uses three sub-miniature valves, two twin triodes and a pentode, in conjunction with printed circuit boards for compactness. The whole preamplifier is shock mounted against vibration. This part of the equipment is relatively simple, the greater part being housed in the pack.

In order to accommodate all the necessary circuitry in such a small space, and to bring power consumption within practical limits, the system is largely transistorised, valves being used only where no suitable transistors are available.

IN THE PACK

The pack contains a free running oscillator and a chain of frequency dividers from which is obtained the vertical and horizontal deflection frequencies. These, in turn, are used to produce a set of synchronising pulses as required by any standard system. Equalising pulses are not generated, but these are, of course, still radiated in the usual way for the benefit of domestic receivers

The transmitter frequency is determined by available channels as indicated by the appropriate channel allocating authority. So far three systems have been developed, one to operate between 174 and 223 Mc, one between 450 and 500 Mc, and one between 6900 and 7400 Mc. The latter was mainly to suit Australian conditions.

Radiated power in the 200 Mc band is 1 watt, at 500 Mc .5 watt, and at 7000 Mc .1 watt. Approximate range at ground level is two miles for the 200 Mc system and 1¼ miles at 7000 Mc. Amplitude modulation is used on the

Alternatively, it may be fitted to an ordinary car. While useful for special program applications, the above installation was made for a completely different purpose. Note the camera cable disappearing under the rear of the car and turn to the next page for the answer.

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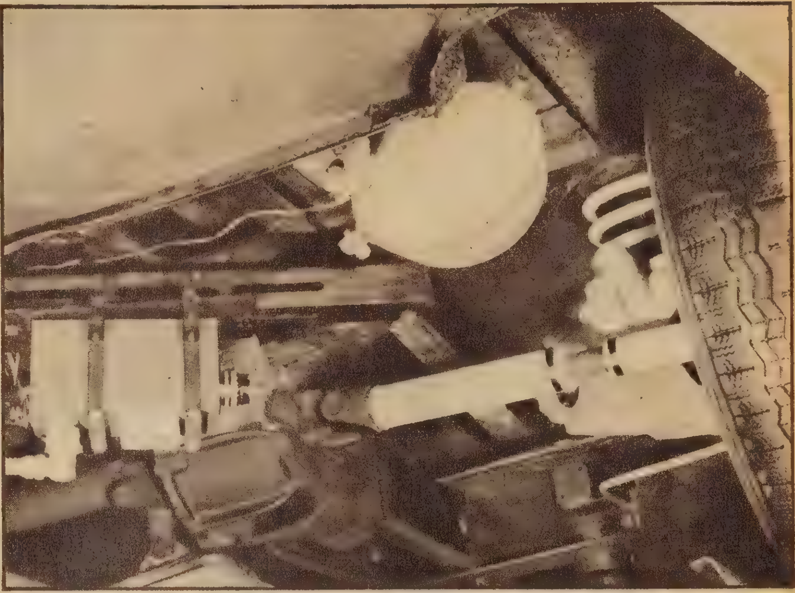

The camera set up to monitor the behaviour of the suspension system. Note that the relevant components have been painted white for easy identification. The flood light is in the top right hand corner.

two lower frequencies and frequency modulation at 7000 Mc.

Power for the whole unit comes from a self contained battery, a 12 volt, 20 A/H silver-zinc type. It is capable of operating the equipment continuously for about four hours. HT voltage for the valve circuits is produced by transistorised inverters. The pack measures approximately 14in square by 5in deep and weighs, complete with battery, aerial and camera cable, about 30lb.

The unit demonstrated by Mr Andrew gave a particularly impressive performance. Those who saw it agreed that the pictures produced were, for practical purposes, comparable with those produced by full size studio cameras and far superior to those from many previous miniature TV cameras designed, admittedly, for less exacting tasks.

APPLICATIONS

The system would seem to lend itself to many applications. The most obvious is the "newsreel" type of job, where it can be used to bring "on-the-spot" pictures of important events, particularly unscheduled ones, which for obvious reason could not be covered by the more bulky OB systems. Cars, jeeps, helicopters, small boats, and plain "shank's pony" will all undoubtedly be used to obtain more interesting and unusual pictures.

As supplied, the unit does not contain aperture correction. This can be applied externally, however, and the improved resolution should allow up to 80 per cent modulation at 400 c/s. It would be reasonable to expect then, that the unit could be used in studio productions where, by reason of its ease of handling, it could provide angles which might be difficult with more conventional equipment.

Again, the radio link may not always be required even for OB work. Where conditions are suitable the system may be connected direct to the OB van by means of regular co-axial cable, the ease of handling of the small camera still providing a very worthwhile advantage. In confined spaces particularly, it frequently is virtually impossible to manhandle a conventional camera and set it up in a reasonable time.

Nor are its uses confined to the entertainment field. In the realm of industrial TV the addition of the radio link makes possible many jobs which would be extremely difficult or completely impossible by any other means.

CLASSIC EXAMPLE

The application illustrated in the accompanying pictures is a classic example. In this case it was desired to observe the performance, under actual road conditions, of a developmental independent rear wheel suspension system of a car; an operation previously carried out by means of film cameras, but which have a number of undesirable limitations.

In this case the complete camera-transmitter system was fitted to the car, with the camera mounted on the chassis and aimed at the suspension system. Light was provided by a floodlight operating from the car's electrical system, and the relevant parts were painted white for easy identification.

The receiving equipment was set up in the centre of the test circuit, and the car sent off around the circuit over the typical types of road surface which such circuits normally provide. The engineers remained at the observation post, carefully watching and noting down all phases of the car's behaviour while it was actually happening. And, if desired, a film record (possibly with recorded commentary), could be made for future reference.

The advantages of such a scheme are many, but one of the main ones would undoubtedly be the ability to create and observe a wide variety of conditions. For example, the car could be sent over a particular type of surface many times, at varying speeds, should the initial run suggest that this was desirable, and all in the period of one session without the delay normally involved in processing motion picture film.

So, whether in the field of entertainment or industry, this system would seem to represent a significant step forward by TV engineers; one which must ultimately result in a better way of doing a number of important jobs.

What the engineer sees on his monitor screen. Taken directly from the screen, this picture gives an excellent idea of the value of the setup in assessing the performance of the suspension system under a variety of road conditions.

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WILL DECIMALS REPLACE £.s.d.?

Our clumsy and outdated currency system has been likened to the weather—everybody complains, but nobody does anything about it! However, there is a chance that a change might be on the way, the Government having appointed a Committee of Enquiry to investigate decimal currency for Australia. The history of decimal currency and how it might be applied to our present system is discussed in this article.

By R. Michel

Adopting the slogan, "A hundred to one it's easier" supporters of the idea of decimal currency in Australia became active three years ago. As a result of public interest in the issue, the Federal Government later set up an expert Committee of Inquiry last year, and that committee has been collecting and considering evidence on all aspects of the proposal. Its report will probably be issued within a few months.

Support for decimal currency in Britain has now come from the Association of British Chambers of Commerce and the British Associaiton for the Advancement of Science. A joint report by the associations, released at the beginning of May, is definite in recommending that Britain should make an immediate change to decimal coinage.

Will these disappear? In any decimal system either our penny or our pound will be replaced by a new unit. It is worth noting that the florin (shown here) is the only British coin aimed at decimalisation, being 1/10th of £1.

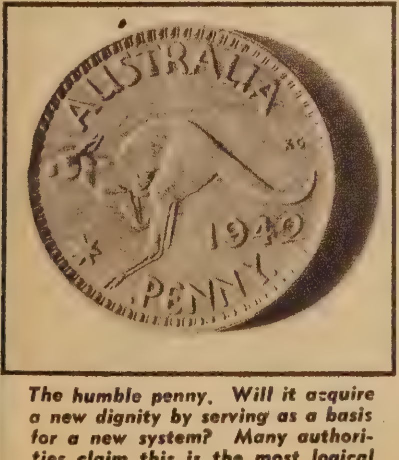
MOST HAVE CHANGED

Since the late eighteenth century, 70 different countries have made the change to decimal currency, although tradition and inertia have proved powerful inhibiting forces in some countries.

Nevertheless, today only Australia, Britain and New Zealand have stood out against all earlier attempts to introduce decimalised currencies.

Among the earliest known converts to a decimal currency were Portugal and Castile. The change was made there early in the thirteenth century.

The modern trend to decimals began with the United States, which made the first step in 1786 and the second in 1792. France followed with a change that began seven years later. Russia made the change in two steps, 1839 and 1847, Canada converted in 1858, the Latin Americas and Japan in 1871, Austria-Hungary in 1870, Germany in 1873, and the Scandinavian States in 1875.



The humble penny. Will it acquire a new dignity by serving as a basis for a new system? Many authorities claim this is the most logical idea.

In more recent times, British areas became involved. British East Africa made the change in 1922, the British West Indies in 1948, Aden in 1951 and Cyprus in 1956. India adopted decimal currency in 1957, and in 1958 South Africa began a change which will lead to the complete adoption of decimal currency by next year.

WHY DECIMALS?

What is the compelling force that has set this trend in motion and sustained its strength?

Briefly stated, it is to be founded in the basic matter of finding a simple method of bringing monetary units into line with the Arabic system of numbering, with its emphasis on building in 10s rather than in other haphazard units.

In the case of our £ s d currency, a hold-over from earlier centuries is involved, and it is attempts to reconcile the complexities of the build-up of 12 pennies into a shilling and 20 shillings into £1 that cause the confusion. A currency in which there are only two units —a major unit, and a minor one which is 1-100th of it—is the simple objective.

Behind the currency problem is the simple arithmetic of counting. Various early civilisations have used different means of counting and referred to the numerals in their own particular language.

These systems have disappeared until today only the system based on ten remains and is now universal throughout the world. This decimal system works simply by counting from 0 to 9 and then starting the process again by putting one before the final figure to indicate that the number includes ten plus the final figure.

The decimal system was introduced into Europe about 1300. It greatly simplified arithmetic and was a much needed improvement over the Roman numerals which did not use a place system.

Before the introduction of the Arabic numerals, the only way of accomplishing the carrying-over trick was by means of the counting frame. This device was invented quite early. Its use was in recording larger numbers than the human head can readily carry.

It probably began in a practice of setting out pebbles in grooves of sand successively representing units, tens, hundreds, and so on.

In whatever way the idea took hold, the abacus or counting frame spread along the trade routes in early times.

MULTIPLES OF 10

With a numeral system based on ten, the counting frame accommodates beads on each of successive columns ordinarily allocated to different decimal orders of magnitude—units, tens, hundreds. The rule is that no column can carry more than nine beads at a time. When there is need to add another bead to a column holding nine already, it is emptied and a bead is added to the next column (which records multiples of the next decimal magnitude). This is the operation of "carrying over."

Only if a means is available of carrying-over is it possible to perform the addition of two large numbers without recourse to counting them one by one.

The Arabic system gave the means of employing this simple carrying-over device into ordinary notations on paper. Essential to it was the concept of the zero, used to denote the "empty" column. It gave us the simple way of expressing the difference between, say, 63, 603 and 630.

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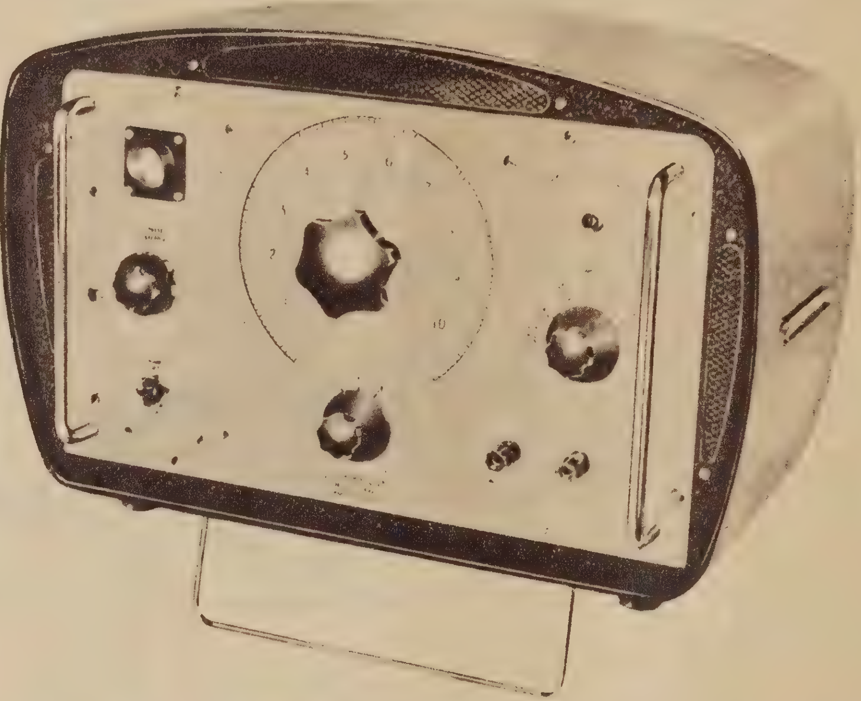

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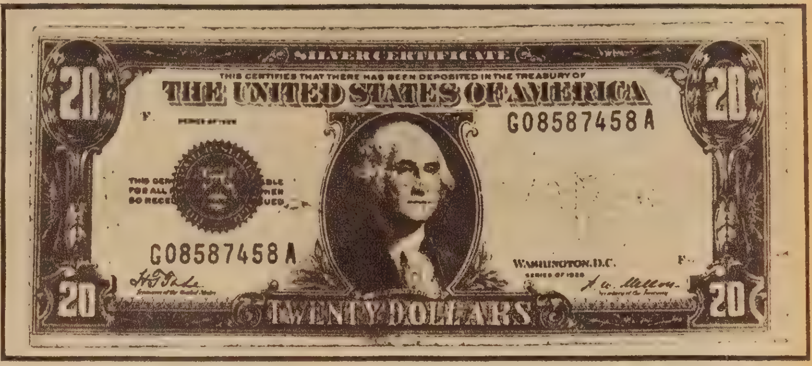
By this means, a number is written as a row of digits, and each place in the row stands for a certain power of 10. Each place to the left of the decimal point indicates that a number is raised to a higher power of 10, and each place to the right of the decimal point indicates division by 10 or raising the number to a negative power of 10. It is this simple means of dealing with quantities less than one that gives a decimal system its great strength.

Decimals are added and subtracted in the same way as are integers or whole numbers except that when these operations are written in columnar form the decimal points in the column entries and in the answer must all be placed one under another.

Similarly, multiplication is simplified. In multiplying two decimals the operation is the same as for integers except that the number of decimal places—that is, digits after the decimal point — is equal to the sum of the decimal places in the factors. Division is also simplified.

Now, while our numbers system works to the principle of ten, the break-up of the £ does not fit conveniently into it. Instead, it is a throw-back to the days when £ was in fact a pound of silver. (The sign £ and the contraction lb are both from the Roman **libra.**)

WELL KNOWN DECIMAL CURRENCY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WASHINGTON, D.C.
TWENTY DOLLARS

Probably the best-known example of decimal currency anywhere in the world; the American system based on dollars (above) and cents (below left), the cent being 1/100th part of a dollar. There are, of course, several intermediate coins.

E PLURIBUS UNUM
ONE CENT
UNITED STATES OF AMERICA

For convenience, the pound of silver was cut into 240 parts, the pennies. This system has descended to us from the time when Charlemagne (742-814 A.D.) introduced a standard currency in Europe. It was introduced into England with the invasion of the Danes, and the pennies were grouped in accordance with old Danish preoccupation with dozens to make up shillings as a convenient mid-coin.

The system has remained in England even though all countries of Europe have adopted the decimal system for their various currencies.

AUSTRALIA'S PROBLEM

Locally, the Committee of Inquiry is concerned with the alternative forms that a new decimalised currency might take; the choice between these alternatives creating its own differences of opinion. The basic question is whether the smaller unit (the equivalent of the present penny) will be retained without change, or whether the larger unit will be the existing £ or the existing 10/. The matter assumes importance because of the varying gains from each in retail trade, in slot machines, in maintaining financial records, in business machines, and so on.

Some claim that the 1d should be retained as the absolute unit of value and the larger unit, 100 pence, be the equivalent of 8/4.

An alternative is to have the present 10/ cut into 100 parts. This would mean that penny values were disturbed and since these have a bearing on so many transactions (including telephone calls, fares, and many items of food), the loss of an exact equivalent of calculation to the 1d is of some concern.

Similarly, the £ broken into 100 parts gives a small unit (2.4 pence) which is not convenient; yet it would preserve many records in a desirable way.

In the long run, the choice between these and other individual systems is a matter of judgment. Many of the difficulties associated with any system apply only or principally during the transitional period.

To demonstrate the gains from a decimal system of currency—and all decimalised systems would have the same merits in calculation—we may assume that 100 pennies equal one major unit in the decimal currency. This means that the total number of pennies involved is shown, with the decimal point ahead of the final two.

The Australian Decimal Research Organisation has prepared examples to show the operation of such a system. Here is the comparison on a simple shopping list of amounts to be added in £ s. d. and then in decimals:

Add—

£	s	d	.
0	3	8	.44
0	4	11	.59
0	18	0	2.16
1	6	7	3.19

In £ s. d. when we add up the pence we obtain 19d, which we remember equals 1/7, so we carry 1 and write 7 in the pence column. For decimals, when we add up the right-hand column and obtain 19 minor units, all we have to do is to carry one and put down 9 in the right-hand column—no conversion is necessary. In £ s. d. the shillings total 26 and we put down six and carry one to the £s. We treat the decimal amounts just as we would ordinary numbers throughout.

As an example of subtraction we can assume that we wish to check our change from a £5 note in £ s. d. and a 10 major unit note in decimals.

£	s	d	.
5	0	0	10.00
—1	6	7	— 3.19
3	13	5	6.81

In £ s. d. we must borrow one from the shillings column, which becomes 12 in the pence column, and subtract 7 from this; also when we borrow from the pounds column we must remember that it represents 20 in the shillings column before we subtract the shillings. In decimals the calculation is just the same as ordinary numbers, meaning that one borrowed from any column to the left of another always represents 10. Besides using special rules in £ s. d. we must make subtractions from larger numbers.

MULTIPLICATION

To take a typical calculation which involves multiplication we may say that we wish to buy seven yards of cloth at 13/11 in £ s. d., which is equivalent to 1.67 in the system of decimal currency we are using.

£	s	d	.
0	13	11	1.67
X0	0	7	X 7
4	17	5	11.69

We remember in £ s. d. that 77d equals 6/5, and do a little mental arithmetic to find that 90/ are equal to four pounds ten shillings. No such working is involved in the decimal calculation.

As an example to compare the steps we use in division in £ s. d. and decimal currency we can take the arithmetic process used by a person calculating their daily wage from a weekly pay of £13/13/9, which is equivalent to 32.85 in our decimal money.

DIVISION

£ s d	.
2 14 9	6.57
5) 13 13 9	5)32.85
10	30
3-60	2.8
13	2.5
73	
70	
3-36	35
9	
45	

(Continued on Page 111)

Four new lives just starting. But what is life? Science cannot answer this—yet—but much has been learned in recent years of the fundamental physics and chemistry of the human body. Such knowledge is invaluable to medical science.

Scientists Probe the Mystery of Life

The nature of life is a matter which has engaged the attention of scientists for countless centuries. By many and varied experiments, they are gradually coming to understand something of the manner in which the human body functions.

by Calvin Walters

FROM the time when man became curious regarding the nature of the life force, scientists have propounded many theories, none of which have thrown much light on the matter.

Nevertheless, man's search has taught him many facts about how the human body works. With these facts, he has been able to design models which behave in a similar fashion to various parts of the human body.

BENEFITS TO MANKIND

The knowledge thus gained has also enabled him to work many wonders in medicine and surgery, by the use of artificial human organs such as the heart, kidney, lungs and so on.

Naturally, with this gain in knowledge, man has given much thought to the problem of whether it would be possible to make a mechanical device which would do the work, both physical and mental, which man is condemned to do for his existence.

This desire, of course, runs in different directions. Firstly, there is the aim of the "boss" to have a lot of mechanical men to replace the workers in his factory; a lot of robots, who won't worry about how many hours they work and won't take "sickies," or go off on "compo." They don't join unions or go out on strike, require no meal hours, holidays, long service pay and other well known amenities.

The fact that they don't eat anything, wear no clothes, pay no rent or go in for hire purchase, don't need doctors, dentists, chemists and transport, doesn't seem to matter very much at present. Modern industry is progressing fairly rapidly towards this goal and no doubt, the end result will be a race of a few intellectuals controlling hordes of robots or other mechanical devices which will be making a lot of stuff that nobody can buy, which doesn't seem a very economical proposition.

Then there is the desire of the "worker" to have a mechanical man to do all his housework so that there will be more leisure time to go to football, golf, bowls, or what have you.

As the years roll on, biologists, biochemists and physicists are learning more and more about the brain and nervous system. Coincidental with this, there is the so-called "push button era," which has given us all kinds of automatic devices, including the wonderful electronic computing devices or "electronic brains" which enable a few operators to carry out, in a few minutes, computations which would have previously taken an army of men months to carry out.

Studies of the nervous system have shown that a stimulus applied at a certain point excites a flow of electricity to the brain, which then sets in motion a system of muscle contractions and expansions.

THE NERVOUS SYSTEM

These in turn actuate levers and joints in the skeleton and bring about movements and other functions.

Thus the mechanical results of stimuli applied to the nervous system are fairly well understood and models can be made to simulate certain of these processes. These are no more than a series of electrical circuits with suitable switches and relays which operate mechanical arrangements of levers in certain prearranged orders.

However, when it comes to the problem of simulating vital processes, such as the living cell, the matter becomes much more difficult.

In order to study a living organ, for example, it is hardly possible to cut a hole in a man with a view to watching what goes on inside.

Surgeons, of course, can see what goes on under one set of conditions. For proper study it is essential to watch the organ under varying sets of circumstances and changes of conditions.

This problem was partly solved in 1935 when Colonel Lindbergh, the famous aviator, designed a special kind of pump called a perfusion pump. In collaboration with Dr Alexis Carrel, Lindbergh carried out a remarkable experiment.

The two men removed a thyroid gland from a cat and enclosed it in a glass chamber in a bath of artificial blood. By means of the perfusion pump, this fluid was pumped through pussy's thyroid gland.

NORMAL FUNCTIONS

For 20 days the gland lived a normal life, except that it was outside instead of inside pussy. The arteries pulsed, its secretions flowed and its cells multiplied and the gland grew.

Twenty-six experiments were carried out on hearts, spleens, kidneys, suprarenal glands and ovaries. All these were kept alive by means of the perfusion pump in an artificial environent.

Science now had a means of studying living organs, enabling them to be view-ed under varying conditions of diet, application of drugs and so on and to find out the conditions under which they best flourish.

Not only could healthy organs be studied, but diseased organs could be observed throughout the course of the disease and thus a possible means of treatment applied and the results observed without the necessity of human "guinea pigs."

Biological models, as these experimental models are called, are extensively used for the study of the living body by simulating the processes in such a way as to lead to an assumption that the way the model works is the way the body works.

ROBBY THE ROBOT WANTS A JOB

"Y'can knock orf now mate, Robby the Robot'll take over." We imagine such a suggestion would be greeted with mixed feelings by most workers. Having Robby do the work would be all right, but who would get the pay envelope at the end of the week. Or would there be a pay envelope?

MYSTERY OF THE CELL

As the mainsprings of human life seem to lie within the protoplasm enclosed within the cells of the body, it is not surprising that the cell is a popular subject for experiment.

In the Carnegie Institute of Washington they made artificial cells consisting of capsules of cellulose lined with jelly-like mixtures and filled them with acid fluid. By placing these cells in alkaline solutions of sodium, potassium, calcium, chlorine and nitrates, the fluid in the cell remained acid for days, yet absorbed selectively the various chemicals from the alkaline solutions in which they were placed. In this respect the artificial cells behaved exactly as the living cells.

At another Carnegie Laboratory in California is a cell model which absorbs sugar and oxygen, combines them and gives off water and carbon dioxide exactly as a living plant cell does.

Chicago University contributed to the biological model idea with one of a nerve cell. This consisted of a special iron wire immersed in strong nitric acid. It has been found that if this wire is jarred, bent, scraped with glass or other substance, it responds much the same as a human nerve.

When a nerve is stimulated, the stimulus must reach a certain critical maximum before the nerve reacts. The same occurs with the iron wire.

Colonel Charles Lindbergh, famous American aviator of a past generation, was also famous for his part in developing the perfusion pump. Lindbergh (left) is shown here with his two co-workers, Dr Carrel (centre) and Professor Fischer.

On the surface of living protoplasm there is a thin surface film in which chemical changes take place, which biologists believe has something to do with the irritability of the protoplasm.

When the wire nerve is first placed in the acid, a similar surface film forms which has the same characteristics as the protoplasmic film, in that it is electrically polarisable, impermeable and can be altered chemically.

Such models can and have been of enormous benefit to biologists and chemists in the search for the truth about life and the living cell.

MATHEMATICAL APPROACH

It is not only by physical models that biologists can observe and deduce.

Deductions have also been made on a mathematical basis, notably by Dr Nicholas Rashevsky of Chicago University who, with a team of co-workers, has been building what he terms "a complete and consistent system of mathematical biology".

Formidable as this may seem to the layman, the principles involved are not as difficult to understand as it may seem. Therefore please don't switch to another article until you have read a bit further. You will then want to continue to the end.

To get some idea of the task which faced Dr Rashevsky and his colleagues, we will first give some brief details of the living organism as outlined by George W. Gray.

All cells are systems of protoplasm

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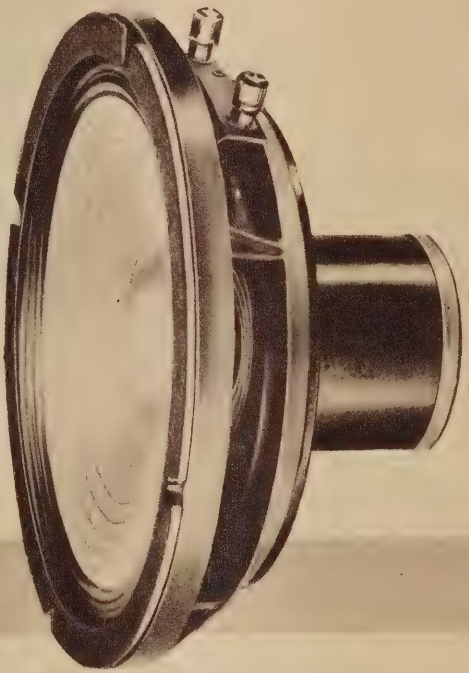

Axiette II

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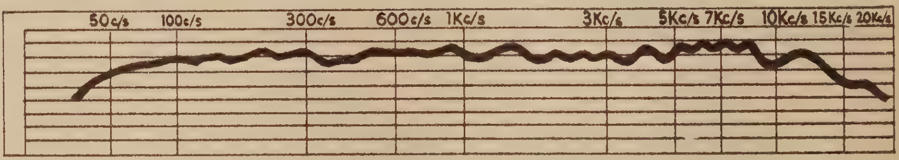

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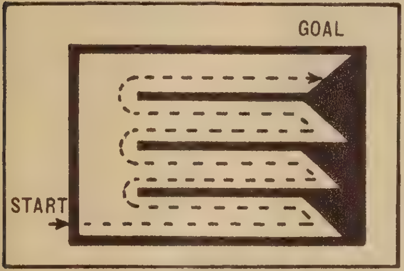
consisting of two general feautres, a nucleus, surrounded by cytoplasm. Cells of various living things vary in shape, size and structural details. The nucleus in turn consists of a complex of chromosomes which, in turn, contain the smaller units called genes. The cytoplasm consists of things called vacuoles, fat globules, gadgets called mitochondria all moving and living.

Out of this complex, Dr Rashevsky proposes to sort out the phenomena into the logical sequences.

According to George Gray, the process which Dr Rashevsky proposes to use is what is called the strategy of abstraction.



The type of maze which several workers have used to demonstrate elementary "learning" and "memory" exercises by artificial brains.

This is the same system as used by Newton, when he propounded the Laws of Gravitation. It consists of choosing the essential features as the centre of attention and ignoring temporarily all the others.

Newton studied the solar system as though only two bodies existed, namely the planet he was studying and the Sun. By abstracting these from the rest he thus simplified the complicated pattern of many encircling planets. He found a fundamental principle and expressed it in a law.

VALID REASONING

This enabled mathematicians later to calculate the mutual disturbances of other planets with such precision that they were able to predict the presence of other planets which were later found as the science of telescope making became more advanced.

Thus a simplification by abstracting the essentials and studying these led to a generalisation of the whole system.

Dr Rashevsky proposed to take what he considered as the irreducible minimum for cell life and then study these. For instance, some cells have walls, others have not, so we don't consider a cellular wall. The majority of cells have nuclei, others have not; therefore we will not study the nucleus.

Thus by a process of elimination Dr Rashevsky gradually abstracted the essential features which are common to all cells and he arrived at the following generalisation in his own words.

"A cell is essentially a small liquid system, a drop, in which occur chemical reactions which result in growth. The substances for these reactions diffuse into the cell from outside and some of the products of the reactions diffuse from the inside out.

"This growing drop, whenever it reaches a critical size, divides in two, each half growing again, and so on. Moreover, division is the only method by which new drops may be formed.

"No drop is formed spontaneously, although all necessary substances may be present in the surrounding medium. We are thus led to a physico-mathematical theory of such droplets as a first approximation to a theory of a cell. And this is no longer a hopeless task."

By assuming that this simplified cell is enclosed in a film which is impermeable to materials from inside, but permeable to materials from outside, and that it is immersed in a liquid medium which contains in solution the material which combine to form the substance of the drop, Dr Rashevsky arrived at a theory of cell formation which seems to be borne out by physical investigation.

RASHEVSKY'S FINDINGS

By the study of diffusions, temperature rates, surface tension, rate of internal reactions and so on, Dr Rashevsky arrived at a purely mathematical basis for growth and reproduction. He showed that there must be a critical size when all the constants mentioned above bring about internal pressures which force the drop to divide.

He found that this critical size of the cell should be about one/three thousandth part of an inch. This is borne out by study of living cells, which shows that they grow to a size within the range shown mathematically by Rashevsky before breaking in two to form the process of reproduction.

In the field of psychology there have been many theories which attempt to explain human behaviour. How do we learn and memorise for instance?

Do we react to our environment in such a way that we are influenced by a previous experience in the same way as a twisted piece of wire? A piece of wire which has been twisted will behave, thereafter, in a different way from a piece which has not been twisted.

It exhibits a property which is called "hysteresis" and appears to "remember" its previous experience of being twisted. After a period of time it will behave more like a normal piece of wire and it can thus be said of it that it has "forgotten" its experience.

Many theorists maintain that the human being is nothing more than a machine which learns in much the same way as the piece of wire and they have attempted to make models which will "learn."

The chappies who theorise thus, say that the only difference between man and a machine is the power of choice which deals with quite another subject of the brain which we will not touch on here.

COMMON EXAMPLE

It may come as a bit of a shock for one to be likened to a piece of wire or an electric elevator. Nevertheless, say some psychologists, there is a great similarity.

An electric elevator will stop at a floor which has been predetermined by the operator pressing a button. Likewise the brain will "press a button" and cause the human mechanism to stop at say, the club on the way home. When you wanted to find out just where the club was, you had to learn it. Thereafter, you found your way by that previous experience.

Working along these lines, the psychologists thought out some ingenious mechanisms to imitate the thinking man. Some of these will interest those who go in for switching arrangements as recently described in this journal.

Take the first diagram which is a picture of the course of a mechanical arm which "learns" its way through a maze. This is the brainchild of one Thomas Ross of Washington, who thought this out as far back as 1928.

It consisted of a system of levers, springs, pinions, electromagnetic relays, and an arm which stuck out of it and which contained a metal contact. When the arm is placed at the entrance to the bottom passage of the maze and the gadget switched on, the arm proceeds along the passage until its tip hits the dead end.

The contact at the end of the arm actuates a switch which puts the arm into reverse. It retraces its course and moves up one to the second passage. Here it goes forward again and this procedure is repeated until the arm reaches its goal at the end of the fourth passage at the top.

MATHEMATICAL MEMORY.

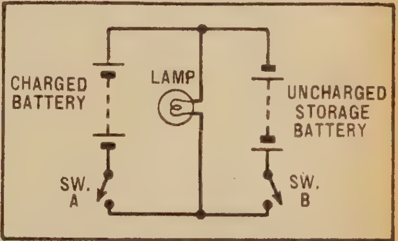
During these excursions, relays and switches inside the gadget have been set so that when the arm is set on its course a second time, it "remembers" the blind alleys and goes straight up and into the fourth passage to its goal.

A refinement of this thing was later developed by Ross in collaboration with Dr Stevenson Smith of the University of Seattle.

This took the form of a small trolley about seven inches wide and a foot long. This ran on a grooved track which was provided with blind alleys at places left and right along its course. When the trolley was set in motion it careered along the track and off into a blind alley. When it hit the dead end, a mechanism within it caused the driving motor to reverse. The trolley then backed along the alley and on to the track again. Here the motor set it forward again but this time it avoided the fork leading to the blind alley.

This was repeated at every fork and alley so that, brought back to its starting point again it went boldly ahead to its destination.

This gadget was called a mechanical rat, owing to the facts that a live rat is known to be expert at learning to negotiate mazes.



Another simple device to demonstrate the science of learning. The uncharged battery associated with switch "B" is an elementary form of memory cell.

The experimenters considered that this mechanical rat closely resembled a "fair dinkum" rat in its behaviour, in that it became conditioned to its environment. In this case the environment was not altered, but after having experienced the environment the machine became trained to it and after one trial

(Continued on Page 127)

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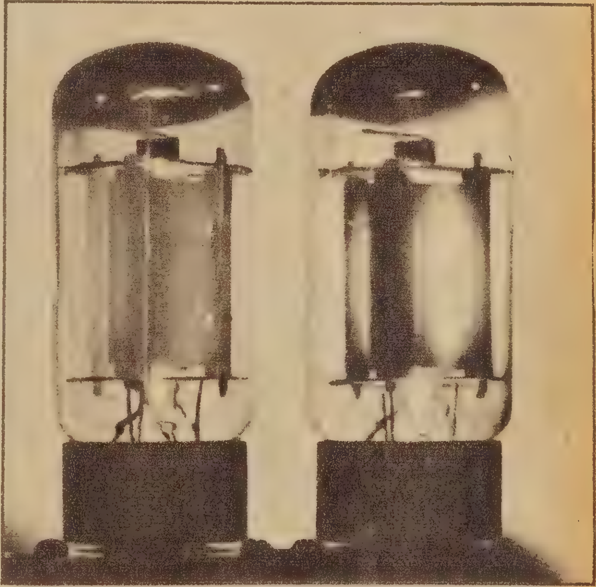
Technical Review

INGENIOUS CONSTRUCTION INCREASES VALVE RATINGS

One of the limiting factors governing the amount of power which output valves can deliver is the permissible internal dissipation, particularly in regard to the plate. Anything which reduces the temperature of this element will allow higher performance figures from the valve.

PICTURES on this page show how a new kind of plate construction increases the maximum output from power pentodes. Two interchangeable audio pentodes are shown, both operating under a severe overload of 80 watts plate dissipation.

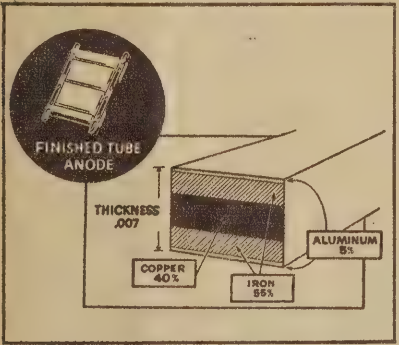


☆

Two similar type valves operating under gross overload conditions. The one on the right uses the old style plate, and displays a bright red spot. The valve on the left uses the new plate and runs much cooler.

☆

In the older type 6L6-GB, whose conventional plate is rated at 22 watts dissipation, the overload causes a hot spot which shows up as a bright red area on the valve's anode (plate). This hot spot limits the available power output.



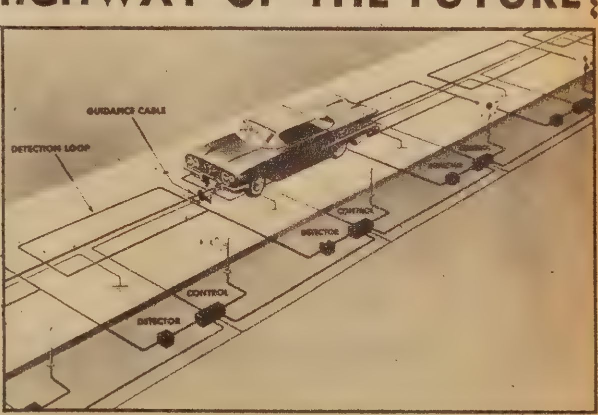
Constructional details of the new anode. Within only .007in there is a copper core, an intermediate iron support, and a sheath of aluminium.

The new valve, a G-E 7581, has ratings similar to the 6L6 except for its plate dissipation, which is 8 watts higher —30 watts. This valve, under the same overload, shows only a dull red glow over the entire surface of its plate because of its unusual construction.

This special kind of plate is made by General Electric and will be used in all their power pentodes. It is a five-layer sandwich of copper, iron and aluminium. G-E starts off with a copper core, adds a layer of iron to each side and coats the whole works with aluminium (see diagram). The copper provides excellent heat dissipation, the iron contributes its strength and the aluminium radiates the heat from the surfaces. As the photograph shows, it works and works well.

A similar method of construction, with a three-ply material, is used for anodes in power rectifiers made by G-E. The metals serve the same purpose with the added feature of having a polished copper surface facing the cathode and reflecting heat to it. This also provides a considerable degree of increased efficiency as compared with older single-metal type rectifier anodes. ("Radio Electronics," June, 1960).

SUPER HIGHWAY OF THE FUTURE



RCA engineers are currently experimenting with a driverless car on a special test track. Here is a diagram of the electronic highway. Main element is guidance cable buried under the road surface. Other elements are rectangular loops at regular intervals, used to space vehicles at a safe distance.

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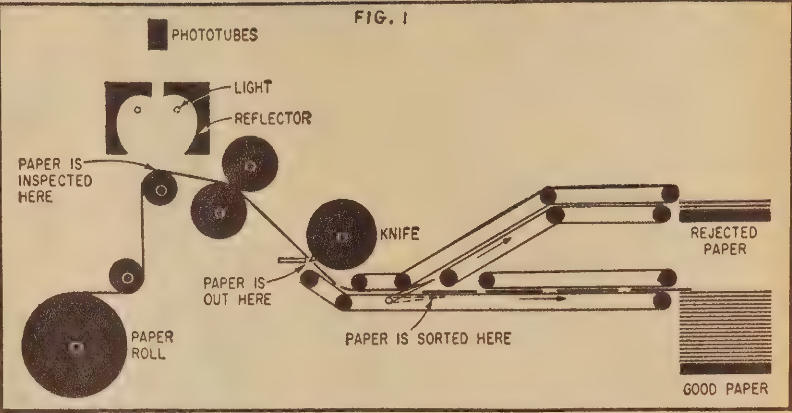
REVIEW—FLAW DETECTOR SOLVES NOISE PROBLEM

The amount of light which is reflected from a flaw in paper is not the same as is reflected from good paper. This characteristic, which applies to almost all defects, is used by the electronic flaw detection system to be described. (From "Electronics.")

FIG. 1



A simplified diagram of the flaw detection system operating in conjunction with a paper cutting and sorting machine. The system can detect flaws lower in amplitude than the noise level in the detection system.

THE sensing element is a multiplier phototube, which is focused on a small area on the paper. The main design problem was to distinguish between the signals which indicate a flaw and the signals due to electronic noise in the multiplier phototubes. Another difficulty was that the detector usually has just one look at a flaw.

A simplified diagram of the detection system and a paper cutter and sorter is shown in Fig. 1. Paper goes into the machine, is cut into sheets of desired length, and then the sheets are piled. The flaw detector inspects the paper while it is in a continuous strip, and if it sees a defect it stores this information in a mechanical memory device. After this inspection the paper is cut, and the cut sheets travel on through the machine to the sorting point. As each sheet arrives at the sorting point, the memory device is automatically checked to see if the sheet contains a flaw.

COMPLETE CHECK

It is necessary to inspect all the paper—a spot check is not good enough—so the equipment must handle information at the rate required for the widest paper travelling at the maximum speed.

The detector looks at a small area of paper 1/16 by 5/16in and this area scans the paper fast enough to inspect the entire surface, even when a sheet 51in wide is travelling at 300ft per min. A spot on the paper is scanned for only about 3 microseconds and, to amplify this signal, the amplifier band-width must be about 1 Mc. Thus, the noise produced in the phototubes is amplified also.

The paper is inspected by means of an ingenious mechanical-optical scanning system. Inside the light reflector is a drum which rotates at 1,800 r.p.m. Eight mirrors are mounted on the periphery of the drum. The light beam from the paper to the phototube is reflected off a mirror, and as the drum rotates, the area on the paper seen by the phototube travels across the paper from one edge to the other.

At the end of a scan, the area on the paper seen by the phototube drops off the edge of the paper and appears at the other edge ready to scan across the paper again. Width of each scan is 5/16in so with a reasonable allowance for overlap each scan covers a strip ¼in wide across the paper. With eight mirrors rotating at 1,800 r.p.m., there are 240 scans per sec. At 300 ft/min., the maximum speed, the paper moves forward ¼in during a scan.

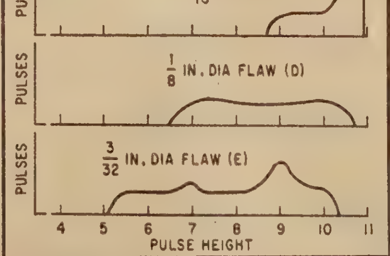
Two mercury lamps, 48in long, with elliptical trough reflectors, illuminate a strip across the paper. The lamps are supplied with two-phase 60 c/s power which gives 240 light peaks per second, one light peak for each scan. Thus, light ripple is not objectionable.

The output from the phototube contains signals which are due to defects in the paper, to variations which are normal in good paper, and to noise in the multiplier phototube. A conventional pulse-height discriminator circuit passes only those signals whose peak amplitudes are above a preset reference level. This circuit does not remove all the noise.

Suppose the reference level, or sensitivity, were set so that all defects in the paper could be detected. At this sensitivity setting a signal due to noise in the phototube would pass the discriminator many times each second. This effect is shown in Fig. 2. Five artificial flaws of the same grey colour but of different sizes were made up. These flaws were scanned a number of times. The heights of the pulses produced by each flaw and the number of pulses of each height are shown in Fig. 2.

Heights of the highest noise pulses in each 0.5 microseconds period are shown by the dashed curve; this curve is in the flaw B box for convenience. The noise curve shows the probability that any 0.5 microseconds period will contain at least one noise pulse of a given height.

FIG. 2



Pulses produced by "typical" flaws, artifically produced. Note that many are lower than the noise pulse. (Shown dotted.)

The highest noise pulse is higher than many of the pulses due to defects. For example, to detect flaw D reliably, the sensitivity level must be set to detect all pulses higher than height 6.5 (just under height D). However, about 33 per cent of the area under the noise curve is above this height, so there should be a noise pulse higher than the sensitivity level in each 1.5-microsecond period.

NOISE PULSES ELIMINATED

Noise pulses are permitted to pass the pulse-height discriminator and then are eliminated. Two identical multiplier phototubes are used, each with identical preamplifiers, amplifiers and pulse height discriminators. One phototube looks at an area of the paper slightly ahead of the other. The output signal from the leading phototube is delayed in a delay line, producing the same effect as if both phototubes looked at the same area at the same time.

Outputs from the two discriminators go to a coincidence circuit. Pulses which are due to real defects occur at the same time, and pass the coincidence circuit; since pulses due to noise are random in time, the probability of getting two coincident noise pulses is small and practically all the noise is eliminated here. However, noise does cause rejection of some sheets.

Another aspect of flaw discrimination is that one cannot set up a standard flaw and say that all flaws greater than this will be rejected and all flaws smaller than this will not be rejected. For example (Fig. 2), to detect flaws A, B and C reliably, the discrimination level must be set at height 7.5. However, about 75 per cent of the D flaws and about 60 per cent of the E flaws will now be detected; these are the amounts of area under the flaw curves to the right of height 7.5. Thus, there will be some unnecessary rejects. For example, in a test run the machine rejected 10 per cent of the paper. When the rejects were re-sorted more than half of them were considered acceptable. However, sorting 10 per cent of the paper is a small job compared with sorting 100 per cent.

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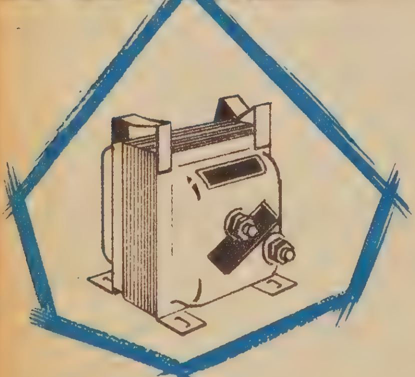

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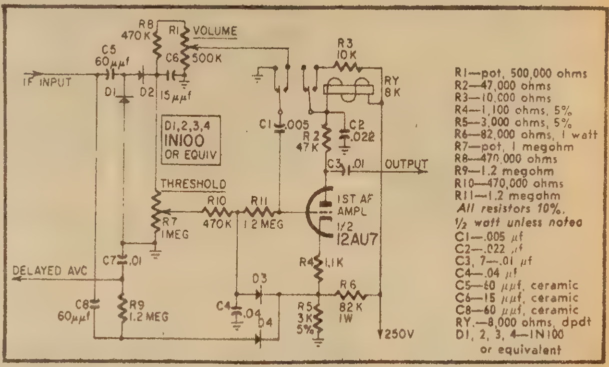
REVIEW — NOVEL SQUELCH SYSTEM WITHOUT VALVES

Wherever a receiver has to monitor an unoccupied channel for long periods, the continual roar or "hash" can be very tiring. Systems to disable the audio system except when a carrier is received, are known as "squelch" circuits and take many forms. This circuit, by R. L. Shaum, W5HEO, is novel in that it does not require any extra valves and makes ingenious use of a relay.



R1—pot, 500,000 ohms
R2—47,000 ohms
R3—10,000 ohms
R4—1,100 ohms, 5%
R5—3,000 ohms, 5%
R6—82,000 ohms, 1 watt
R7—pot, 1 megohm
R8—470,000 ohms
R9—1.2 megohm
R10—470,000 ohms
R11—1.2 megohm
All resistors 10%, ½ watt unless noted
C1—.005 μf
C2—.022 μf
C3, 7—.01 μf
C4—.04 μf
C5—60 μμf, ceramic
C6—15 μμf, ceramic
C8—60 μμf, ceramic
RY.—8,000 ohms, dpdt
D1, 2, 3, 4—1N100 or equivalent

☆

Fig. 4. A more comprehensive circuit using delayed AVC and a squelch threshold control. The relay is the only component likely to need a special order.

☆

THERE is a way to add a relay squelch circuit to almost any receiver without adding another valve to amplify the AVC voltage. No additional valve is needed if the first audio amplifier is used as a dc amplfier in addition to its normal audio function.

Fig. 1 shows a conventional first audio amplifier stage. It normally draws about 1.5-ma plate current. Fig. 2 shows that plate load resistor R2 has been changed from 100,000 to 47,000 ohms. This almost doubles the valve's class-A current so a 2-ma relay may be reliably closed. The relay is placed in series with the plate load resistor, where it becomes a part of the power supply decoupling network consisting of R3 and C2.

Because relays usually close at a particular current and remain closed even when the current is reduced to some fraction of its original value, something must be done to keep the squelch from locking on threshold signals. For the 8,000-ohm relay shown, the closing current is 1.8-ma and the opening current 0.8-ma. A 10,000-ohms resistor placed across its coil will shunt nearly half of its current, so we place the resistor across the coil and through a set of normally open contacts on the relay. When the relay closes (at 1.8 ma), it shunts itself and reduces its coil current to 1 ma, or the threshold of opening. When plate current drops slightly, the relay opens, removes its shunt resistor and automatically becomes sensitive to closure again. This relay, then, operates over the small plate current range of 1.7 to 1.8 ma.

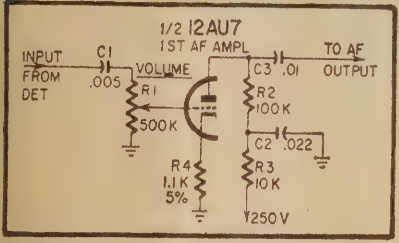


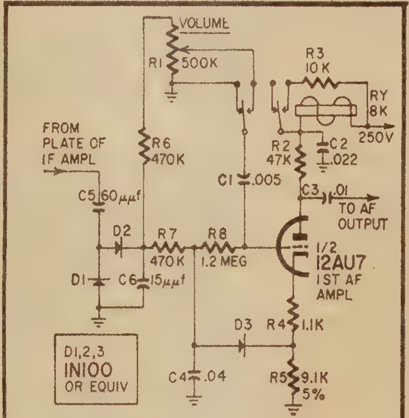
Fig. 1. A conventional 1st audio amplifier before fitting a squelch circuit.

NO-SIGNAL CONDITION

In Fig. 2, if the grid is earthed, as it is when no signal is being applied, the bias developed through R4 and R5 will allow only about 1.5 ma of plate current to flow. If the relay is open, the current is insufficient to close it. On the other hand, if the relay was previously closed, the shunt resistor would reduce relay current to less than 0.8 ma, and it opens anyway.

The 0.1-ma differential plate current represents a plate-voltage variation of about 5 volts. It is not enough to change the operating point of the amplifier appreciably, but this operating point could be disturbed by the incoming direct-current switching signal. Even if AVC is used, the voltage may be in the order of 50 to 60. D3, which clamps the grid return to the junction of R4 and R5, limits the switching voltage. The bottom of R4 is the normal grid-return point, and it therefore represents the proper class-A amplifier bias setting. Thus the switching signal cannot saturate the valve and cause audio distortion.

The squelch action occurs when the switching signal from the voltage doubler (consisting of C5, C6 and diodes D1 and D2) drops to about 6 volts. When this happens, the relay opens, and a second set of its contacts switches the grid coupling capacitor C1 from the audio source to ground, with resultant silence. When an incoming carrier causes the voltage across C4 to rise to about 12, the relay closes and applies audio to the grid again. This function, of course, could as easily be in the speaker circuit.



R1—pot, 500,000 ohms
R2—47,000 ohms
R3—10,000 ohms
R4—1,100 ohms, 5%
R5—9,100 ohms, 5%
R6, 7—470,000 ohms
R8—1.2 megohms
All resistors 10%, ½ watt unless noted
C1—.005 μf
C2—.022 μf
C3—.01 μf
C4—.04 μf
C5—60 μμf ceramic
C6—15 μμf ceramic
D1, 2, 3—1N100 or equivalent
RY—8,000 ohms, dpdt

Fig. 2. The audio amplifier as modified for squelch operation. Note the 10K resistor to modify relay sensitivity.

There are ways to improve the squelch circuit, but for various reasons they were found to be undesirable. For example, a 12 to 15-volt Zener diode could be substituted for R5 to produce higher dc gain, but Zener diodes are still somewhat expensive. The dc gain at R5 can be maintained by adding a resistor from R5 to B-plus so about 15 volts of bias is developed, but the voltage divider would drain 3 to 5 ma, and this may not be desirable in the case of a marginal power supply. Fig. 3 shows this system.

Some precautions must be taken to assure best results from the squelch circuit. The receiver should have delayed AVC. Fig. 4 illustrates a simple way to get it. The bias arrangement of Fig. 2 may not have the desired voltage stability, so it would be preferable to use that of Fig. 3.

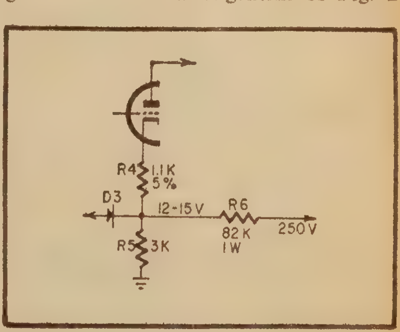


Fig. 3. Modification to provide bias from the HT supply.

If audio is heard when the relay is open, there is a good possibility that C4 is not large enough; but if C4 is made too large it will slow down the response of the relay. Actually, a little audio can be reassuring to the listener. If it is annoying, it would be better to switch the audio at the plate or speaker output.

(Continued on page 99.)

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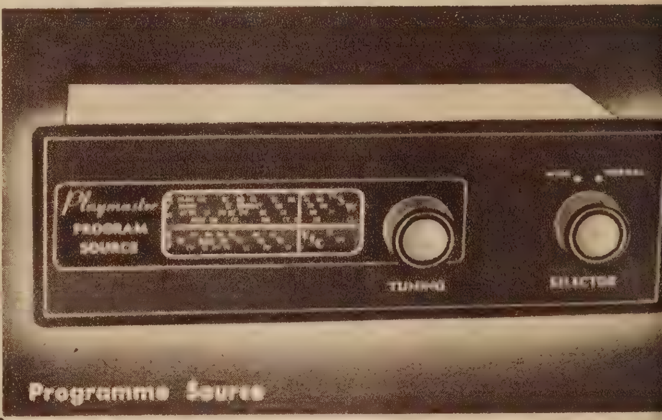

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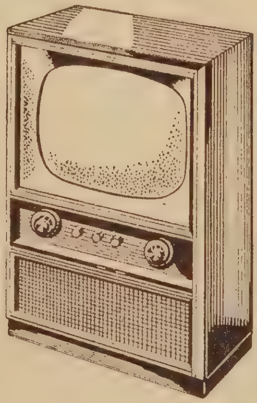

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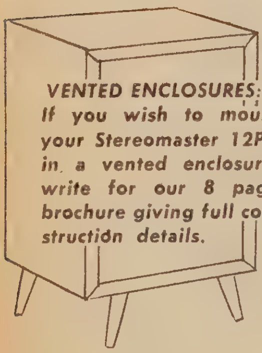

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Power handling capacity	20 watts peak
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Frequency response	45 c.p.s. — 12 K.C.
Voice coil impedance	15 ohms at 400 c.p.s.
Air gap flux density	12,800 gausses
Total gap flux	87,000 lines

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RE5

SCIENTIFIC & INDUSTRIAL NEWS

STRONGEST MATERIAL?

A NOVEL material, which is claimed by the Norwegian scientists responsible for discovering it to be several hundred times stronger than steel, is now the subject of a detailed investigation.

Experimental tests carried out with the new material are said to have shown that it is approximately twice as strong as the needles of quartz crystals—one of the strongest materials hitherto known.

The research so far carried out has suggested that a fibre of the new material with a thickness of only one square millimetre is able to carry a suspended load of about 10 tons.

The material, which is in the form of pure crystals, was discovered during research into the surface conditions occurring in niobium oxide (or columbium oxide).

Cand. real Joar Markali, Sentralinstitututtet for Industriell Forskning, Forskningsvien 1, Blindern, Oslo, Norway.

VERSATILE TIN COMPOUND

A NEW tin compound is said to stretch like rubber and can be vulcanised.

The rubber-like tin material has exceptional resistance to exposure to high temperatures, and at the same time is able to withstand the attack of corrosive chemicals, such as chemical fuels, far better than conventional rubber.

The compound depends on the fact that tin is substituted for carbon, the usual base of rubber, in manufacturing the new plastic-like material. The new material is basically alkyl tin methacrylate, and it is expected that this basic form will lead to the development of a whole new series of rubber-like compounds in which carbon has been replaced.

Malayan Tin Bureau, 1028 Connecticut Avenue N.W., Washington 6, D.C., U.S.A.

CORROSION DETECTION

A NEW device for measuring corrosion of metals is said to detect the progress of corrosion almost "atom by atom." The device depends on the use of a special probe containing an element coated with a film of metal 2-millionths of an inch to 50-millionths of an inch thick.

The device can detect metal losses of as little as 5,000 millionths of an inch. If desired, the surface of the vacuum deposited metal film—which can be made of different metals according to requirements—can be sensitised by means of a special chemical treatment to enable even more accurate observations to be made.

Tests have shown that the instrument can be used for the rapid detection of the concentration of corrosive compounds even when this is extremely small. The device can detect the slightest change in humidity, water content, ozone concentration, or other factors which may affect corrosion.

Thompson Ramo Woolridge Co., P.O. Box 45067, Airport Station, Los Angeles, California, U.S.A.

FLAME-RESISTANCE FOR FABRICS

COTTON fabrics and certain blends of cotton with spun viscose rayon can be treated with a new durable flame-resistant finish now available in Britain. It does not impair the "handle" of fabrics, nor does laundering or dry-cleaning reduce its effectiveness. Furthermore, the finish does not affect the strength of fabrics.

The treatment consists in applying a pre-formed phosphorus-nitrogen mixture to the fabric and polymerising this by chemical curing. The limitation on the application of the finish to blended fabrics is that the proportion of viscose should not be more than 50 per cent.

An important aspect of the use of the new finish is said to be the prevention of smouldering or "after-glow" after burning fabric is extinguished.

Proban, 1 Knightsbridge Green, London, S.W.1, England.

UNUSUAL BRUSHES

A BRITISH company claims to have made a complete break with conventional paint-brush design in the introduction of its U-Brush.

Owing to a patented system of grouping the bristles the brush is said to hold about three times the normal load of paint carried by conventional brushes. In addition the tendency of paint to accumulate at the roots of the bristles is avoided.

Ucan Centres, 62 Hill Street, Richmond, Surrey, England.

TEMPERATURE RESISTANT GLOVES

A NEW glove provides complete protection to temperatures ranging from nearly minus 460 degrees Fahrenheit up to plus 1,200 degrees F.

The gloves are not bulky and are manufactured in such a manner that the wearer can manipulate instruments and dials easily.

The hand of the wearer remained completely warm while liquid nitrogen was held in the cupped palm of the glove. Moreover, the evaporation of the liquid nitrogen did not harm the leather skin of the glove.

Metal parts heated to temperatures of over 1,000 degrees Fahrenheit have been held in hands protected by the gloves in a similar fashion with no discomfort.

The gloves also give protection against immersion in boiling water. Essentially the glove consists of three elements—a basic rubber unit worn next to the hand and a specially tanned leather glove, which is worn over the top of this basic unit to give protection from cold, while a specially developed aluminised asbestos glove is used in place of the leather outer covering to give protection from heat.

Although the new glove was developed originally for military purposes, it is expected to have widespread applications throughout industry.

J. M. Rubin and Sons, 180 Maddison Avenue, New York, N.Y., U.S.A.

TURBO-JETS TAKE TO THE WATER

Cutaway view of a new hydrofoil boat developed by the Grumman Aircraft company for the U.S. Maritime Administration. It is powered by two General Electric Company turboshaft engines and is expected to have a top speed of 60 to 80 knots. The main engine is the type 240, designed to develop 20,000 shaft horsepower, while the auxiliary engine for harbour and docking use is a model 720 developing 900 shaft horsepower.

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COLLARO STUDIO TAPE TRANSCRIPTION DECK

FINEST QUALITY!
FULLY IMPORTED!
UNBEATABLE LOW PRICE!

SPECIFICATIONS

Medium	Standard ¼″ Plastic or paper base coated tape.
Track Width	.087″ - .091″;
Number of Tracks	Two.
Record/Playback Sense	Left to Right only.
Number of Motors and Type	Three. Four pole, Induction, dual voltage.
Voltage	200-250V. 50 cycle & 110/50 cycles by change of connections; 110V. 60 cycles by change of motors.
Operating Consumption	Max. 24 watts at 230 volts.
Operating Speeds	1⅞″, 3¾″ and 7½″ per second.
Number of Heads	Two.
Head Types	One Record/Playback, one Erase.
Heads, Additional	Space provided for the fitting of a monitor head or a stereo playback head.
Record Head Gap	.00025″.
Record Head Impedance	30 K ohms at 10 KCS.
Attainable Frequency Response	12 KC at 7½″ per second ± 3 db with Record/Playback equalisation.
Recommended Erase & Bias Frequencies	45-60 KCS.
Erase Head Impedance	200/300 ohms at 45-60 KCS.
Erasing Voltage	Approximately 25 volts at 120 M/A.
Playing Time	120, 60 and 30 minutes per standard 1,200 ft. reel.
Rewind Times	65 seconds per 7″ spool of 1,200 ft. 45 seconds per 5¾″ spool of 850 ft.
Wow & Flutter	Not greater than .15% at 3¾″ p.s.
Long Term Speed Stability	Better than .5%.
Dimensions 12½″ x 10⅝″	With 5¾″ spools within the confines of the Unit Plate. With 7″ spools overlapping Unit Plate.
Plane of Operation	Horizontal.
Weight	14 lbs.

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68a Railway Parade
West Perth — 28-3111

FIGHTING OIL POLLUTION

A BRITISH company has designed air-inflated flexible booms for the prevention of oil pollution during handling operations between ships or barges and shore installations.

Consisting of long oil-resistant rubber tubes ranging between eight and 18 inches in diameter, the booms have a weighted skirt suspended below them to act as a barrier against oil spread. The tubes in various lengths up to 50 feet are designed to be joined to give any desired arrangement of barriers.

Any tension in the tubes caused by waves or other contingencies is taken-up by a chain fastened to the skirt of the boom. For quick removal at the end of handling operations one type of boom sinks to the sea or river bed when deflated.

William Warne and Co., India Rubber Mills, Barking, Essex, England.

ELECTRONIC STORE-KEEPING

A SPECIALISED computer functions as an electronic "store-keeper." It can record up to 50 million items under 5,000 different headings.

The basic model costs £4,750. It is a compact console unit and has an electric typewriter specially adapted to initiate the recording of information.

The machine shows the quantity of goods being placed or taken out of stock and also the number of items in stock before the transaction.

It also calculates the new stock position and types this out. Alternatively, the amount of stock in any or all of the categories can be obtained, each item coming up separately in the digit panel provided.

Electronic Machine Company, Mayday Road, Thornton Heath, Surrey, England.

FROST RESISTANT ROAD SURFACING

TESTS have been carried out in Norway during the past winter on a new type of frost-resistant road surfacing material.

The new material can provide the basis for a low-cost surface for previously untreated roads. The tests, which were carried out under stringent conditions showed that the new surface remains flexible at very low temperatures, thereby resisting frost damage.

Basically the new material consists of gravel mixed with what is said to "road oil." It is similar in appearance to heavy fuel oil, and forms a hard and firm, though flexible, road surface with good road holding properties.

British Petroleum Co. Ltd., Britannic House, Finsbury Circus, E.C.2., England.

KEEPING HEAT IN

COMPLETE insulation in a building so that the heat is kept in and the cold out is not easy, particularly where there are corners and recesses which are out of reach. Insulation of pipes is also a time-consuming operation.

The problem has however been largely overcome by the development of a special foam plastics material which can be sprayed on. The material turns into a foam plastic as it is built up on the surface to be covered and enables the most awkward corners to be filled.

It emerges under pressure from a spray gun in an already catalysed condition.

In a semi-fluid condition, the material is forced into the cavities to be insulated and because of the pressure behind it the foam "climbs" vertically and will thus fill spaces around nests of pipes and almost inaccessible ducting.

Although of open-cell construction, the foam is claimed to have quick drying-off qualities and it will not hold moisture for any length of time. White in colour, non-inflammable and immune to fungal growth the material is suitable as an insulating material for refrigerators, frozen food cabinets and counters and also for insulating hot-air ducts and hot-water pipes at temperatures up to 250 degrees Centigrade.

Jabloc Plastics, Waddon, Croydon, Surrey, England.

FASTER FIRE FIGHTING

A NEW chemical compound that is said to put out fires involving oil and petrol twice as fast as any fire-fighting compounds previously developed, has been tested extensively on an experimental scale, and is now to be prepared for commercial production.

The new compound, which is in the form of a powder, is non-toxic and inexpensive. It can be used in fire-fighting appliances of conventional design.

Tests carried out with the powder, which is purple in colour and based on a pulverised form of potassium bicarbonate, have shown that it will extinguish an oil fire similar to that caused by a crashing plane within 11 seconds.

U.S. Naval Research Laboratory, Washington, D.C., U.S.A.

ROOFING FOR VANS

ONE-PIECE roofs for large vans made from fibreglass which are translucent enough to enable drivers to dispense with artificial lighting in daytime are being made in Staffordshire, England.

Over 24 feet long, the roofs are moulded with ribs designed to make them independent structural units for attachment to van bodies.

Advantages of this material, especially with high-roofed vehicles, are its lightness, corrosion-free surface, and ease of repair. The thermal insulation properties which are superior to steel are said to offer advantages for carriers of bakery, confectionery and other products.

Hill's Fibreglass, Rose Works, Lichfield Road, Wednesfield, Staffs., England.

PAINT HARDENER

A NEW solventless liquid epoxide resin hardener system enables paint coatings of 0.010 inch to 0.015 inch thick to be produced in a single application.

Previously it has been necessary in most cases to apply several coats of these paints in order to provide sufficient film thickness to resist mechanical damage, while protecting metal surfaces against corrosion.

The new epoxide coatings can be applied readily to structural steel work, most metals, wood and concrete.

At the same time pigments can be incorporated in the system.

The compound has been formulated so that when it is applied to vertical surfaces the minimum amount of drainage occurs.

The RADIOMASTER

RADIOGRAM CHASSIS . . .

A great performer on Radio and Records

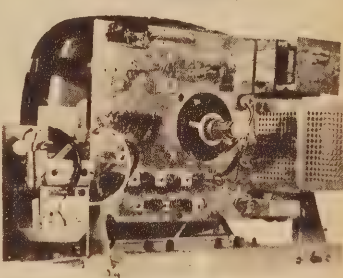
STEREO MODEL S77 gives glorious three-dimensional sound that comes from everywhere in the room. Features include dual treble, bass and volume controls, also balance control. Broadcast and short-wave radio. Seven valves. Single chassis. Two speakers.

PRICE, £38/10/-

Stereo Model S66, 6 valves £31/10/-

Packing included. Freight extra.

TELEVISION CHASSIS



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The complete transmitter and modulator is built on a single 6 x 10in chassis. The left hand side of the chassis and panel accommodates the modulator, and the right hand side the transmitter. Meters are (left) modulation depth and stage-by-stage tuning meter.

Simple Transmitter For Two Metres

Here is a small, easy-to-build transmitter for the two-metre band. Whether you are a brand new amateur operator, anxious to get on the air, or a long time 40-metre man looking for contacts on a VHF band, this compact unit is guaranteed to produce quite impressive results.

By Keith Jeffcoat (VK2BK) and Vol. Molesworth, M.A. (VK2VO).

ONE of the interesting developments in amateur radio in recent years has been the growing number of stations operating on very high frequency (VHF) bands.

This is due, in large measure, to the fact that it is no longer necessary to pass a test in morse code to obtain a licence to use these bands.

ABOVE 50 Mc.

Once the P.M.G. examinations in radio theory and operating regulations have been passed, the new amateur is permitted to operate on telephony on certain amateur bands above 50 megacycles.

The most popular of these bands is that from 144 to 148 Mc., known as the "two metre" band.

In addition to holders of limited radio operators' licences (or "Z" calls) the two metre band has attracted a number of full-licensed operators (those who have passed the morse code test) because it is singularly free from both natural and man-made interference.

Freedom from interference and clarity of reception are the principal advantages of the two metre band.

Its only disadvantage is that it has a limited range. (This is no drawback if you are not particularly interested in working DX).

Like television, two metres is theoretically a "line of sight" band. However, contacts have been established over many hundreds of miles.

The New South Wales record, at the moment, is a contact made between North Sydney and Twofold Bay, on the South Coast, a distance of more than 260 miles.

Using the equipment described this month and a moderate four-element beam, contact has been made in the past year with more than 75 different stations, in and around Sydney, and to Newcastle.

The transmitter was used in conjunction with the two metre converter described in the February 1959, issue of this journal, feeding into an AMR300 receiver.

The unit to be described this month consists of a transmitter, modulator and power supply. Except for the coils, which are wound by hand, standard radio components can be used throughout.

ATTENTION TO LAYOUT

A little more care in layout and wiring is necessary in two metre equipment than in ordinary radio gear and special attention must be paid to rigidity.

While recognising this, the transmitter to be described here was wired up by a beginner in two week-ends, was put on the air on July 1, 1959, and has operated dead on frequency ever since, despite numerous knocks and bumps. It has never had to be realigned and the only modification made has been to alter the modulator tube.

The main difference between a two metre transmitter and one required for use on (say) 40 metres is that more multiplying stages are needed to reach the final transmitting frequency.

For 40 metres, or 7 Mc, the oscillator can run at 3.5 mcs., and only one additional stage is necessary to double this frequency to the final frequency of 7 Mc. Or, of course, a direct 7 Mc oscillator may be used.

On two metres, however, if we begin with an 8 Mc crystal, it is necessary to multiply no fewer than 18 times to reach the final frequency of 144 Mc.

This is one of the reasons why it is better to use a crystal-controlled oscillator than a variable frequency oscillator (VFO).

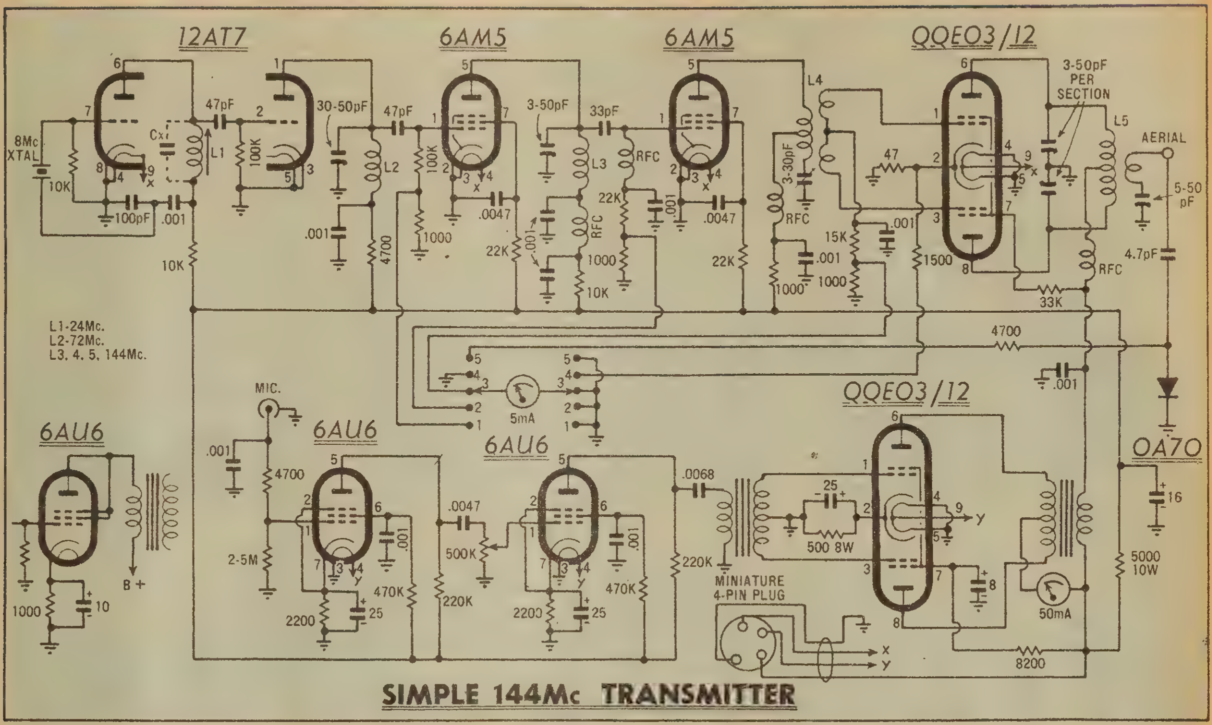
VFO DRIFT

If the VFO drifts a few cycles, there will be 18 times the amount of drift at the transmitted frequency. Despite this, a number of operators are using VFO-controlled transmitters on 144 Mc.

The transmitter described here, however, is crystal-locked to ensure stability.

There are a number of ways in which the required frequency of 144 Mc. can be obtained. One way would be to begin with a crystal on 9 Mc and double all the way through, multiplying in succes-

CIRCUIT OF 2 METRE TRANSMITTER & MODULATOR



The transmitter proper is shown in the upper part of the circuit, with the modulator beneath it. (The power supply is shown separately.) The first half of the 12AT7 operates as an overtone crystal oscillator, and the second half as a tripler, bringing the 8 Mc crystal up to 72 Mc in two stages. The 6AM5 then doubles to 144 Mc.

sive stages to 18, 36, 72 and finally 144 Mc.

Another way would be to begin with a crystal on 6 Mc, triple to 18, and then follow the above line.

There are several objections to either of these procedures, however. In the first place, doublers are not as efficient at the lower frequencies as triplers.

Secondly, output at 36 Mc could very well cause interference to television receivers (TVI) with an intermediate frequency in that region.

TELEVISION INTERFERENCE

Thirdly, if a harmonic oscillator circuit is used, a crystal on 9 Mc may have a quite strong output on its seventh harmonic, at 63 Mc, where it can also cause television interference.

The same applies to a 7 Mc crystal which may produce a strong ninth harmonic of 63 Mc.

We must avoid "TVI" at all costs.

If we start with a crystal on 8 Mc, we can triple in our first stage to 24 Mc, triple again in our second stage to 72 Mc, and then double from 72 to 144 Mc. The second "hop" takes us right over the band of frequencies which cause TVI.

The procedure used in our transmitter was to begin with an 8 Mc crystal in an overtone circuit whch produces output at 24 Mc but no output on the fundamental frequency crystal which was 8013.5 Kc.

Avoid this exact frequency or it will clash with the author's transmitter. Any crystal between 8 and 8.22 Mc (approx.) should land between 144 and 148 Mc.

(Editor's Note: Output from a crystal used in an overtone circuit may not be an exact multiple of the crystal's fundamental mode. Band-edge operation should be avoided, therefore, unless means are available for checking the final frequency independently and accurately. In the set described here, the final frequency was approximately 388 cps lower than that calculated mathematically.)

One half of a 12AT7 nine-pin miniature valve is used in the overtone circuit producing output on 24.04 Mc, while the second half of the same valve acts as a tripler, multiplying the frequency to 72.1 Mc.

DOUBLER

This is fed to the grid of a 6AM5 seven-pin miniature valve, the circuit of which is arranged as a doubler, multiplying the frequency to 144.2 Mc. This is nicely inside the two-metre band. (Most of the stations in Sydney and Melbourne operate within the first 1.5 Mc of the 4 Mc wide band).

The next 6AM5 is wired as a straight-through amplifier. It does not multiply the frequency any higher, but amplifies it so that we have sufficient output at 144.2 Mc to drive the final valve, which is a QQE03/12 nine-pin miniature tube.

The "QQ" series of valves may not be familiar to a number of readers who have worked only with 40 metre equipment. They are basically twin tetrodes, having a common screen grid and a common cathode.

These valves are self-neutralised to frequencies in the region of 250-300 Mc, require very little driving power and deliver large amounts of RF.

The QQE03/12 is about the same size as a 6M5 and, with 300 volts on the plates and 200 on the screen, its output is 18½ watts. Grid current should be 3mA, and about .2 watts is needed to drive the tube.

TAPPED FILAMENT

The QQE03/12 has a centre-tapped filament, allowing operation at either 12.6 or 6.3 volts. (Its American equivalent is the 6360). It has a "big brother," the QQE06/40, which is similar to the well-known 829B and is used as a high-powered final on two metres.

The transmitter here being described can be used as an exciter to drive a QQE06/40, which is capable of operating with 100 watts DC input.

A number of excellent modulators have been described in this magazine which could be used to provide the audio for this transmitter. Alternatively, for operators on lower frequencies coming on to two metres, the existing modulator can be used, providing the correct impedance match can be made to the modulated stage.

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U.C.C. manufacture a comprehensive range of radio-type single electrolytics. This range is covered in can sizes from ½" dia. x ¾" long to 1" dia. x 3½" long. The capacity voltage is in a combination of sizes up to 1,000 μF at 1.5 VW and up to 80 μF at 500 VW.

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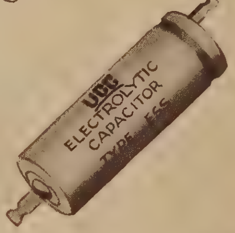
The quality of U.C.C. electrolytic capacitors is guaranteed through high production standards and strict quality control tests during every stage of manufacture.

A comprehensive range of mounting styles is available, including pigtail and vertical mounting types as illustrated.



TECHNICAL DATA

CAPACITANCE TOLERANCE:

0 to 100 volts — 10% + 100%   101 volts and over — 10% + 50%

POWER FACTOR:

0 to 100 volts inclusive 30% at 100 cycles per second.
101 volts and over 15% at 100 cycles per second.

WORKING VOLTAGE:

This is the sum of the D.C. voltage and A.C. ripple voltage which can be applied to the capacitor for continuous operation.

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CAPACITOR
TYPE ERA

PEAK RIPPLE VOLTAGE:

Is the instantaneous value of A.C. voltage across the capacitor caused by the A.C. component. This voltage, as a rule, should not exceed 6% of the rated peak working voltage at 100 cycles per second or 12% of the rated peak working voltage at 50 cycles per second.

PEAK OR SURGE VOLTAGE:

Is the maximum voltage the capacitor will withstand without damage when connected in series with the resistor having a value of $\frac{20,000}{C}$ ohms for 30 seconds: the voltage is measured across the resistor/capacitor combination.

LEAKAGE CURRENT:

All ER and ES type electrolytic capacitors have a finite leakage current. When first connected to a power source the charging current is high, but rapidly drops to a normal value as given by the formula:

$$I = \left(\frac{CV}{10} + 100\right)\ \mu A.$$

C = Capacity in microfarads.
V = Working voltage.
I = Current in microamperes.

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ELECTROLYTIC
CAPACITOR
TYPE ERE

It should be noted that the leakage current given by this formula is the maximum acceptable for satisfactory performance and is normally less than half this value. All readings should be taken at 25°C. after applying the working voltage for five minutes; plus one minute for every month of shelf-storage.

TEMPERATURE:

The effect of temperature is important and it is closely related to and affects all characteristics. The ratings of type ER and ES electrolytic capacitors are based on a maximum temperature of 85°C. The temperature co-efficients of capacity and leakage current are positive whilst that of the power factor is negative.

SHELF-LIFE:

Idle storage has a deteriorating effect on the anode film and should electrolytic capacitors be stored for any length of time they should be re-aged. This is most easily accomplished by applying 90% of the rated voltage to the capacitor in series with a 10,000 ohm heavy duty resistor.

Initially due to a high leakage current the voltage applied to the capacitor will be low, gradually increasing as the current decreases. When the leakage current reaches the rated value the capacitor is ready for use.

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CAPACITOR
TYPE ERL

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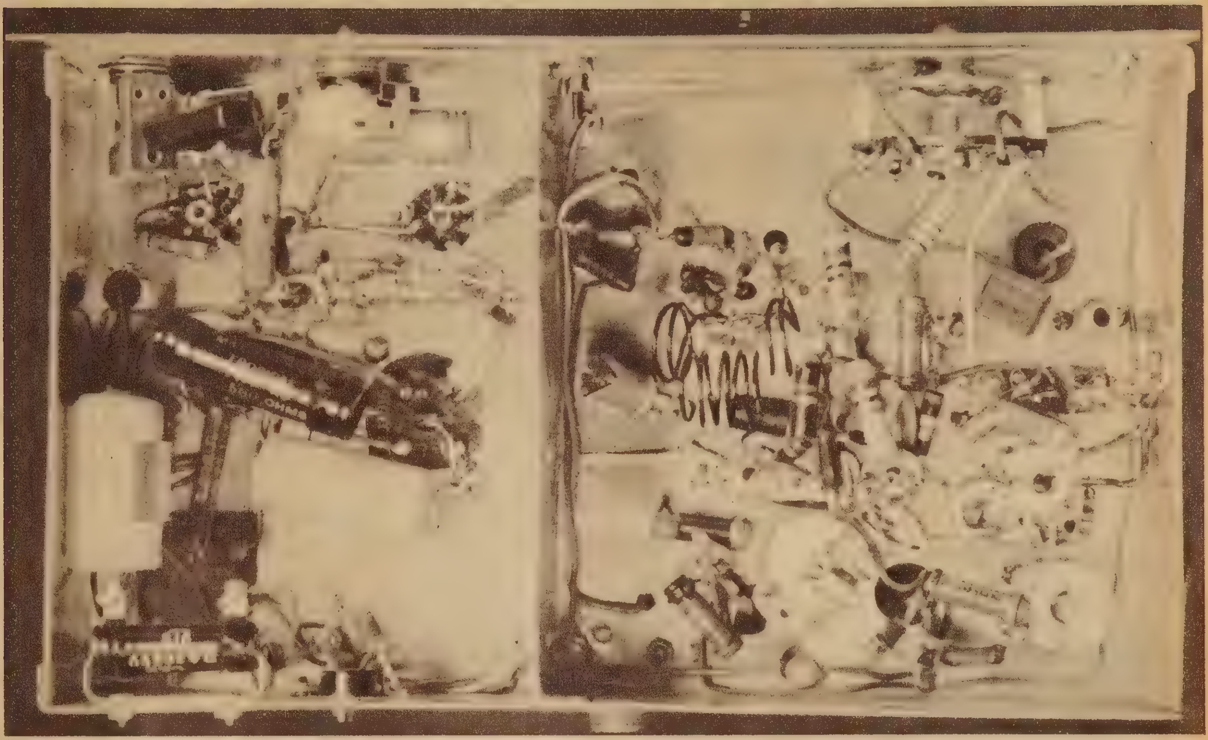
ADELAIDE .... Stephen & Co., 53 Wyatt St.
BRISBANE .... John Morris, 62-72 Albert St.
PERTH .... O. F. Gamble, 931a Hay St.
TASMANIA .... G. A. W. Wood, 46 Brisbane St., Launceston
NEW ZEALAND .... H. W. Clarke (N.Z.) Ltd., 42 Cable St., Wellington

CHASSIS LAYOUT IS DIVIDED INTO TWO SECTIONS



The left hand compartment of the chassis contains the modulator section, and the right hand one the transmitter. The audio gain control is at top left and the transmitter metering switch at the top right. The crystal socket and 24 Mc coil are at extreme right, mid-way up the chassis. The 72 Mc coil is just below them, seen end on.

The modulator used in this transmitter has undergone one change, which is worth mentioning because it brings out an important point. When first placed on the air, the transmitter was modulated by a 12AU7 miniature 9-pin twin triode operating in Class AB2. Bias was obtained from a tiny hearing aid 15-volt battery.

A crystal microphone was fed into a 6AU6 miniature 7-pin pentode with five megohms in the grid. The speech was further amplified by a second 6AU6, and the output from this stage transformer-coupled to the grids of the 12AU7.

Output from the plates of the 12AU7 was delivered to a push-pull modulation transformer and transferred to the final via the secondary.

MODULATION TRANSFORMER

Commercially-made transformers are available which will do these jobs, but we happened to have on hand the driver and modulation transformers from a disposals transmitter type 522.

If you should also have these on hand, remember that it is undesirable to pass DC through the 522 driver transformer (type A103016), and the stage must be shunt-fed. If you are using a new commercially-made driver transformer, it can be placed directly in the B-plus line to the plate.

While the modulator worked reasonably well, it was found that a greater depth of modulation was needed to really punch a signal through to out-of-town contacts.

To gain more audio-power, a second QQE03/12 was pressed into service. The 12AU7 socket was rewired to accommodate the tube, and the stage placed in service in Class AB1. This gave a considerable improvement in modulation depth.

A common power supply is used for both transmitter and modulator. There does not appear to be any tendency for one to pull the other. Separate filament supplies were used for each unit, simply because they happened to be available. The transformer provides 300 volts DC and is rated at 100mA. It has never shown the slightest tendency to get warm.

To enable the unit to be thoroughly checked while in operation, and to facili-

PARTS LIST

2 chassis each 10in x 6in
1 power transformer, 325 volts per side at 100mA, 5v, 2 x 6.3v.
1 filter choke, 100mA.
1 driver transformer (Bramco B30 or similar).
1 modulation transformer (Ferguson MT 118 or similar).
1 2 x 5 rotary switch
1 ¼in slug-tuned coil former
4 7-pin miniature valve sockets
3 9-pin miniature valve sockets
1 octal socket
2 toggle switches
1 microphone jack
1 coaxial aerial socket
1 OA70 diode
1 5mA meter
1 50mA meter
1 crystal (8 to 8.22 mcs.) with holder and socket to suit.

VALVES

1 12AT7, 2 6AU6, 2 6AM5, 2 QQE03/12, 1 5U4

RESISTORS

All ½W unless specified.

1 47 ohm
1 500 ohm 8 watt
1 1000 ohm
4 1500 ohm
2 2200 ohm
2 4700 ohm
1 5000 ohm, 10W
2 8200 ohm
3 10K
3 15K
1 33K
2 100K
5 220K
1 500K pot.
2 470K
2 4.7M

CAPACITORS

1 5 pF
1 33 pF
2 47 pF
1 100 pF
10 .001 mfd
3 16 mfd electrolytic 500V-600V
1 3-30 pF trimmer
2 3-50 pF variable
1 butterfly capacitor 3-50 pF per section.

MISCELLANEOUS: Tag strips, coil winding wire, knobs, nuts and bolts, 4-pin speaker plug and socket.

ELECTRONIC A&R EQUIPMENT

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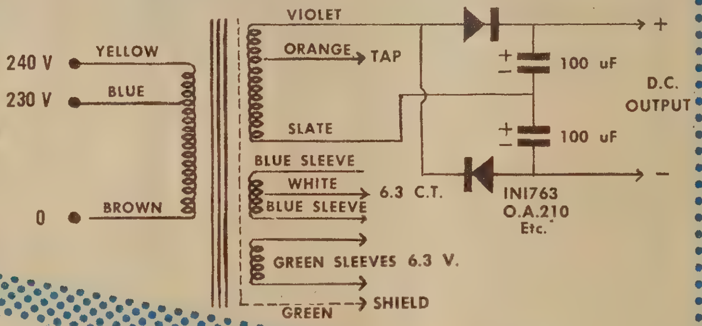

✱ All voltages given are those obtained under fully loaded conditions. Maximum temperature rise 45°C, fully loaded.

CHARACTERISTICS

TYPE No.	D.C. OUTPUT M.A.	D.C. OUTPUT VOLTS	A.C. SECONDARY VOLTS	FILAMENTS		EFFECTIVE R (See note*) OHMS.	WEIGHT		OVERALL HEIGHT INCHES	MOUNTING DIMENSIONS INCHES	BASE DIMENSIONS INCHES	MOUNTING TYPE
				VOLTS	AMPS.		LBS.	OZS.				
2062	80	290 265	115 TAP 105	6.3 C.T. —	2.25	25	2	2	3½	2⅛ x 2⁵⁄₁₆	2⅞ x 3	VLN 31
2063	80	340 315	135 TAP 125	6.3 C.T. —	2.25	29	2	3	3½	2⅛ x 2⁵⁄₁₆	2⅞ x 3	VLN 31
2064	125	340 315	135 TAP 125	6.3 C.T. — 6.3 C.T. —	2.25 2.25	16	4	15	3⅞	2½ x 2⁹⁄₁₆	3½ x 3⁵⁄₁₆	VLN 34
2065	150	290 265	115 TAP 105	6.3 C.T. —	6	10	5	11	3⅞	2¾ x 2⁹⁄₁₆	3¾ x 3⁵⁄₁₆	VLN 34
2066	190	320 265	125 TAP 105	6.3 C.T. —	6	7	6	8	3⅞	3 x 2⁹⁄₁₆	4 x 3⁵⁄₁₆	VLN 34

Note* — Effective Transformer Series Resistance referred to Secondary

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A. & R. ELECTRONIC EQUIPMENT CO. PTY. LTD. *378 St. Kilda Road, Melbourne, S.C.1. MX 1150, MX 1159* tate original testing and lining-up, we have been generous in metering facilities. Grid drive to each of the 6AM5's is metered, the P.A. current is read for dip, and a separate current meter is inserted in the modulator.

For tuning up, an RF indicator has been added, and wired to a spare position on the meter switch.

The transmitter under discussion can be used for either base station or mobile operation. If your car uses a 12-volt battery, the two 6AM5's in the transmitter and the two 6AU6's in the modulator can each be wired as a pair in series, all of the remaining tubes having 12-volt filaments.

The transmitter-modulation chassis is then clamped into the car, and a genemotor, vibrator or transistorised convertor unit plugged into its power input section.

BASE STATION

The unit photographed here is wired for base station 6.3 volt operation.

The transmitter was built on two 10in by 6in chassis, the transmitter and modulator occupying one, the power supply the other.

The photographs show the general layout of the transmitter.

Looking at the transmitter chassis from the rear, the transmitter proper is at the left, and the modulator section at the right.

The two sections can be shielded by a vertical metal plate. In the prototype model, shielding was not necessary to prevent RF feedback, the short vertical plate shown in the photograph serving merely to support the front panel.

Heart of the transmitter is the crystal oscillator. The D.C.11 crystal holder is mounted close to the oscillator valve.

If a larger chassis is used, the multiplying stages should lead in a straight line to the grids of the final stage. (Radio frequencies do not take happily to turning too many corners at 144 megacycles.)

We were able to get away with one turn, however, which enabled us to begin with the crystal at the far left hand side of the chassis, with the oscillator valve immediately behind it. This feeds through the multiplying stages and driver stage to the final tube.

The tank coil and P.A. tuning capacitor are mounted on the front panel above the chassis to avoid RF feedback to the grids of the power amplifier valve, which are at the socket below the chassis.

METERING

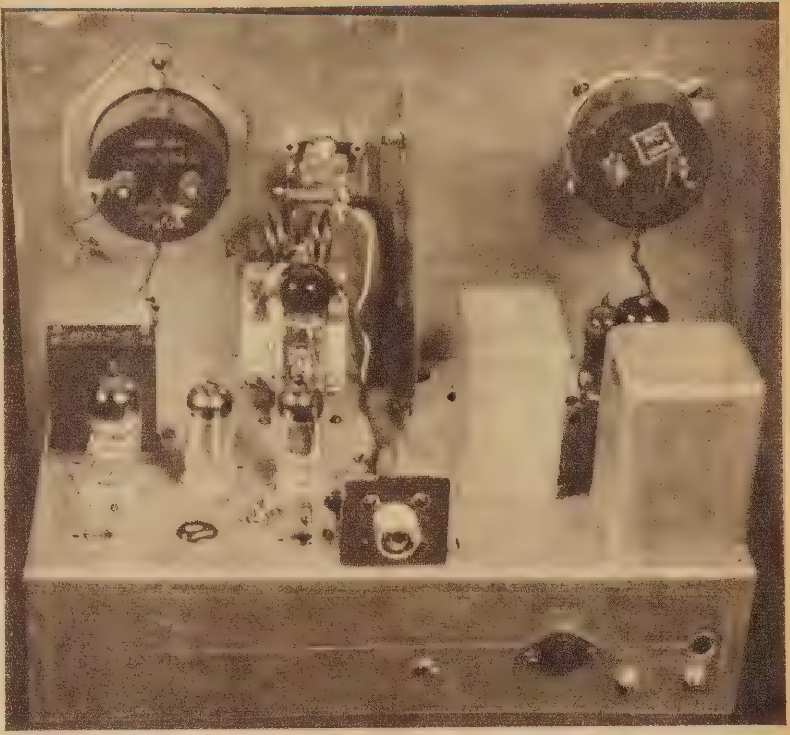
There is room near the crystal for a meter, and a meter switch can be fitted below the chassis.

The two 6AU6 valves in the modulator section are set just behind the front panel, the microphone amplifier at the right and the driver to the left. Behind the driver is the driver transformer, to its right the modulator stage, and behind it again the push-pull modulation transformer.

Connection to the aerial is made at the rear of the chassis. The small capacitor 5(pF), OA70 diode and 5k resistor in the "RF indicator" network are mounted on a three-lug tagstrip immediately beside the coaxial output socket. Power input is by means of a four-pin miniature socket at the right hand rear of the chassis.

Looking at the unit from the front, the 10in x 12in panel supports the modulation meter at left and the multi-function meter at right. The former has 50mA full scale deflection and the latter 5mA f.s.d. (Both are disposals types, the latter borrowed from an AT5 transmitter).

ABOVE CHASSIS LAYOUT DETAILS



The major component layout is shown here, with the transmitter on the left. The three valves in a row are (from left), the 12AT7 overtone oscillator and tripler, 6AM5 doubler, 6AM5 straight amplifier, and QQEO3/12 final partly obscured. The butterfly tuning capacitor is behind this valve.

Alongside the 5mA meter is the "aerial trimmer" control, which operates a small variable condenser in series with the aerial coupling link to earth. This is used to tune any reactance out of the aerial feedline in order to get maximum RF output.

Below the aerial trimmer is the P.A. tuning control, set once and never since varied.

Along the bottom of the panel (left to right) are the microphone jack and audio gain knob, and the meter function switch.

This switch is a two-pole five-position switch. It enables us to read grid drive to each of the 6AM5s, plate current "dip" in the final, and an indication of RF output. After the unit has been initially lined up, the meter may be left on "RF indication" for all future operation.

RIGID WIRING

The wiring of the unit may seem untidy to hi-fi amplifier builders but, at very least, the components handling VHF must be wired with short leads, from point to point. Indeed, the only hook-up wire used in the whole unit was for filament and B-plus leads and certain leads to the meters and the meter switch. Everything else is point to point and use has been made of tag-strips to support components in the interest of rigidity.

In the modulation section, however, some untidiness has been caused by changing the modulator from a 12AU7 to a QQE03/12. You can use "pretty" wiring here if you like. Notice that, underneath the chassis, the modulator side has been shielded from the transmitter by an end-folded aluminium sheet.

There are several coils to wind for this transmitter.

First is the plate coil of the overtone oscillator (first half of the 12AT7) designed to take the output of that valve at the third harmonic of the fundamental crystal frequency (24 Mc). This coil is wound with 24 turns of 32 SWG gauge wire on a ¼in diameter slug-tuned former. We found it necessary to screw the slug about halfway in.

72 MC COIL

The next coil is in the plate circuit of the tripling stage (second half of the 12AT7) and must resonate at 72 Mc. This consists of 9 turns of 18 gauge wire, half an inch in diameter and spaced to 1in.

The third coil is in the tuned circuit in the plate of the doubler (first 6AM5) which must resonate at 144 Mc. It consists of four turns, as above, spaced to ¾ inch.

Coil number four is in the series tuned circuit in the plate of our straight-through amplifier (the second 6AM5).

It consists of five turns, ¾in diameter and ¾in long centre tapped.

The grid coils of the QQE03/12 are of similar wire and diameter, and consist of two turns at each end of the series-tuned coil.

Above the chassis, the tank coil is made of 14 gauge wire, and consists of four turns ¾in in diameter and

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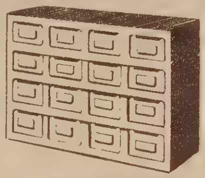

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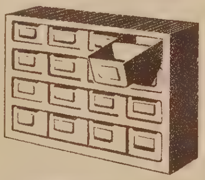

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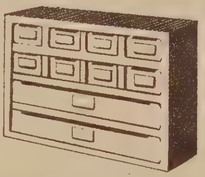

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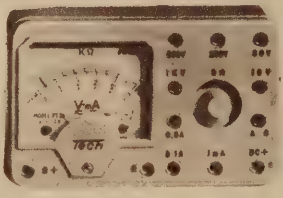

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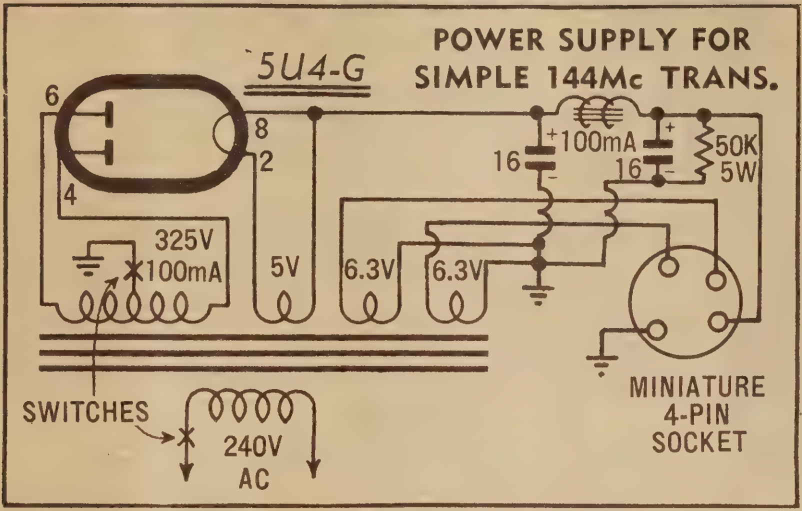


The circuit shown is the one used for the original transmitter, but almost any arrangement capable of supplying around 300 volts at 100 mA would be satisfactory. However, regulation should be capable of coping with the class B modulator section.

spaced to take a one-turn link in the middle for aerial coupling.

A grid-dip oscillator will make the "setting" of these coils very easy. Failing this, the coils can be spread or compressed until indication of drive to the next stage is obtained.

A word to the newcomer, here. Do not attempt to resonate coils without their associated valves plugged in and the filaments switched on. Tube capacitances have a considerable effect on the resonant frequency of a tuned circuit.

The circuit of the modulator is quite straightforward, and calls for little discussion. If there appears to be a tendency for the amplifier to "squeal" with RF feedback, insert an RF choke in the cathode of the first 6AU6.

Filament and B-plus leads may be bypassed with 1000 pF. capacitors, preferably the small ceramic disc types suitable for VHF. (Do not attempt to use mica capacitors, or capacitors from the junk-box, or you will wonder where the RF went.)

OSCILLATOR

Coming now to the transmitter, the oscillator is a "Robert Dollar" overtone circuit. The crystal is wired between the grid and a capacitive network between anode and cathode of the first triode section of the 12AT7.

This is an overtone circuit. Output is to be taken from the plate at three times the fundamental frequency of the crystal. When the circuit is functioning correctly, you should not be able to pick up output at 8 Mc in your receiver, but output should be detectable at 24 Mc (if your receiver tunes that high).

The degree of oscillation in the Robert Dollar circuit is governed by the ratio of the two capacitors by-passing the cold end of the plate coil. The simplest way to obtain the correct ratio is to fix the value of the larger capacitor and then vary the value of the smaller capacitor until sufficient regeneration is obtained to make the circuit oscillate smoothly.

In our case, we started with .001mfd as the larger value, and 50pF as the smaller. We found that this caused too fierce a regeneration, which resulted not only in the crystal oscillating on its fundamental, but also produced excessive crystal current which could lead to a possible fracture of the crystal itself.

To protect the crystal, and to ensure that the circuit would oscillate only on the third harmonic, we increased the value of the smaller capacitor to 100 pF. (Some crystals are not as suitable for overtone oscillators as others, and it may be necessary to vary the ratio of your capacitors to obtain positive third-harmonic output).

One half of a 12AT7 works nicely in this circuit, and leaves the second half as a triode for a normal "tripler" circuit. Other suitable valves include a 6SN7, 6SL7, or 12AU7, and would call for little circuit alteration.

Looking at the circuit, a dotted capacitor (Cx) will be seen wired across the coil L1. In the prototype, there was sufficient inductance in this coil to resonate it merely by tuning the slug. If there is not sufficient inductance in the coil you wind, a little added capacitance (5-10) pF) may be needed to tune the circuit.

We used a 6AM5 as our doubler. This is a power amplifier pentode with an output of about 1.4 watts, with very low current drain on the filament (200 mA) making it desirable for mobile work. Substitute tubes would include a 6AQ5, with a heavier filament current drain, or a 6AK6, which has an even lower filament drain.

It may have been possible to have driven the QQE03/12 with the output of the first 6AM5. Some experimenters may get away without the second 6AM5. However, at VHF, it is not good practice to operate valves at their maximum ratings or to skimp drive. To make sure that ample drive would be present at all times, a second 6AM5 was wired in as "straight through" amplifier. This gave us 3mA of drive to the grids of the final, with plenty in reserve.

RF CHOKES

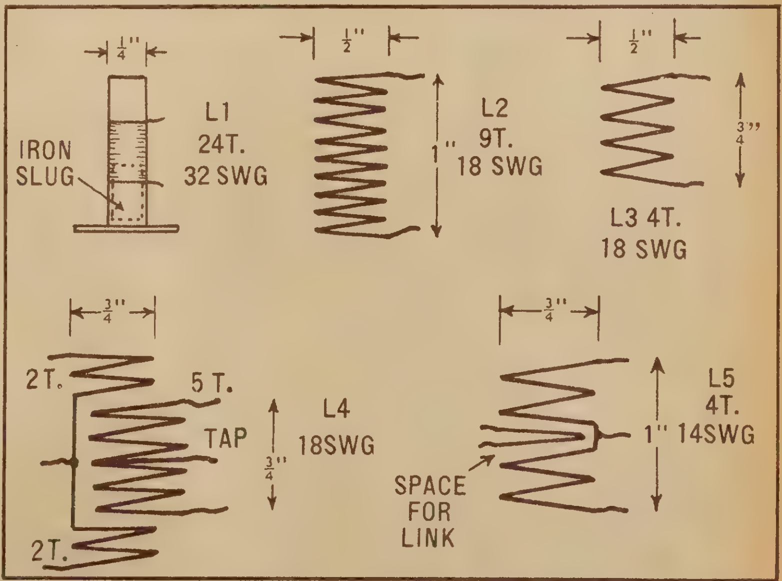
Since the second 6AM5 was operating with 144 Mc. at both its grid and its plate, special RF chokes were wound to prevent RF feedback which would turn the tube into a tuned plate tuned-grid oscillator. These RF chokes are wound with 15 turns of No. 30 gauge SWG wire closewound on a high-value carbon ½W resistor.

The leads of the by-pass capacitors at the cold ends of the RF chokes should be cut as short as possible and wired straight from the end of the choke to the one earth point common to that circuit.

Each stage of the transmitter should have all of its earth returns soldered to the one point. Keep these leads as short as possible.

The transmitter employs parallel-tuned circuits in all stages, except in the plate circuit of the second 6AM5. This is a series-tuned circuit, and the function of the 3-30pF trimmer capacitor is

(Continued on page 43)



This coil data is taken directly from the finished transmitter, after pruning each stage for optimum performance. All coils will naturally need some adjustment, but should be quite close to the mark. A grid dip oscillator is a great help during preliminary setting-up operations.

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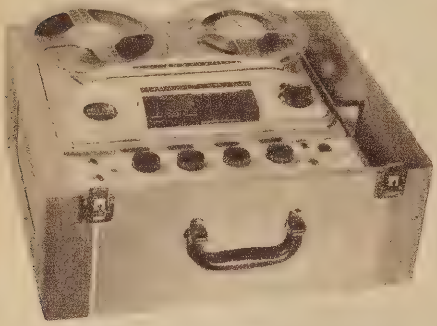
IN HI-FI TAPE RECORDERS



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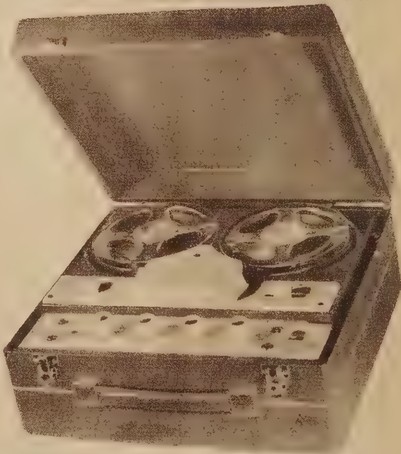
The recorder is fitted in attractive two-tone case with dual speakers and microphone.

Overall dimensions 14in x 10in x 6½in. Weight 26lb.



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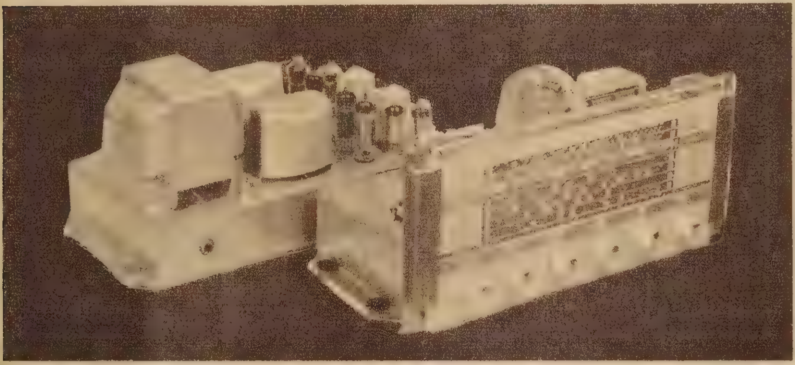

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to tune the centre-tapped coil in association with the valve and stray capacitances, attaching to the upper section.

Adjustment to the coil inductance can be made by squeezing together or spreading apart the turns.

The two adjustments should be made simultaneously with a view to maintaining resonance but, at the same time, balancing the capacitances between each end of the coil and earth. This ensures that the RF potential at each will likewise be balanced, contributing to balanced drive to the two output grids.

Coupling the grid coils to the series-tuned plate coil is very critical. If the coupling is either too tight or too loose, insufficient grid drive will result. When tuning up, it is necessary to adjust the coupling and tuning of the series-tuned coil until sufficient grid drive is obtained to the QQE03/12. Do not forget to make a solid earth connection to the centre of the P.A. tuning butterfly capacitor.

INITIAL TESTS

When setting up the transmitter, first remove all the valves from the transmitter and modulator. Switch on the power supply with the rectifier valve in its socket, and preferably with a bleed resistor temporarily in circuit to limit the HT voltage. If everything appears to be in order, plug in the 12AT7.

If you have a receiver capable of tuning 24 Mc, disconnect the outside aerial and run a length of hook-up wire from the aerial terminal to a point near the transmitter. Switch on the BFO and tune around 24 Mcs until a strong carrier is heard. To determine whether it is output from the 12AT7, remove the crystal from its socket. If the carrier disappears, you are on frequency.

Now tune the slug in the coil former in the plate circuit of the first half of the 12AT7 for maximum output. This should not alter the frequency more than a few hundred cycles, as judged by the BFO. If it does, it may indicate that the circuit is not being effectively controlled by the crystal. At this stage, it would be a good idea to switch the receiver to the 8 Mc region and see if any oscillation is taking place on the crystal fundamental. If so, remember what we said earlier about varying the value of the smaller capacitor in the oscillator circuit.

TRANSMITTER ADJUSTMENTS

Having got this far, plug in the first 6AM5, and switch the meter to position No. 1 Tune the 3-50 pF variable capacitor across L2 for indication of maximum drive to the grid of the 6AM5. Some squeezing or spreading of the turns of L2 may be needed, but do not alter the coil too much or you may end up doubling instead of tripling, and come out at 48 mcs instead of 72 mcs.

Plug in the second 6AM5, turn the meter to position No.2, and repeat the above procedure, again looking for maximum indication on the meter. About one-third scale deflection will be ample. Before proceeding any further, pick up the soldering iron and temporarily lift the lead from the modulation transformer to the plates and screen of the QQE03/12.

Now plug in the final valve, switch the meter to position 3, and look for an indication of grid drive. As discussed earlier, careful adjustments to both the plate circuitry of the second 6AM5 and the grid coupling to the QQE03/12 will be necessary to obtain maximum drive. About half-scale on the meter will be ample.

Having reconnected high tension to the final, switch to meter position 4 and tune the P.A. condenser for a dip, which will reach about half-scale.

Now you are ready to put your new transmitter on the air.

With the antenna connected, the plate load will rise slightly. Switch the meter to position 5, and slightly retune the P.A. condenser and the "aerial trimmer" for maximum indication on the meter. In the prototype, the needle goes nearly off-scale.

As a final check, switch in your two metre converter with its aerial disconnected, tune to approximately the 18th multiple of your fundamental crystal frequency, and briefly switch in the new transmitter. Output will be heard in the receiver, but do not be surprised if the strongest output is not exactly where your calculations show it should be.

An overtone oscillator does not necessarily operate on exactly three times the crystal frequency, so the final output may well be a few kcs either side. Standard procedure is used to check the modulator, which should present no problems.

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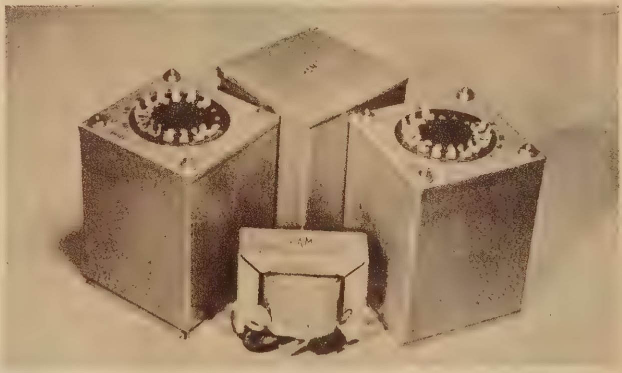

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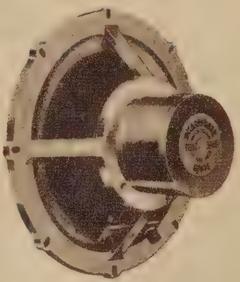
Total Flux 155,000 maxwells.	Total Flux 44,000 maxwells.
Foam surround.	Foam surround.
Copper voice coil.	Aluminium voice coil and centre dome.
Fundamental resonance 25-30 c/s.	

COLUMN 8/145

Bass Resonance 45/55 c/s.
Flux Density 14,500 gauss.
Total Flux 60,000 maxwells.



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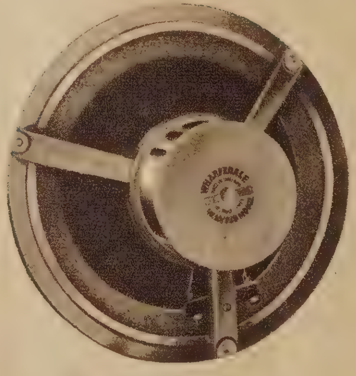
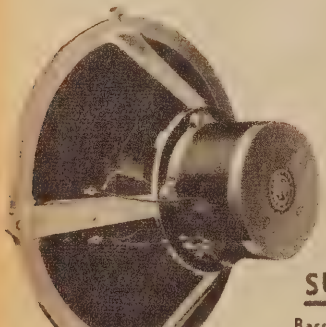
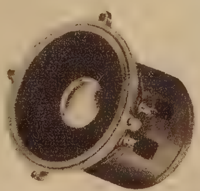




SUPER 12/FS/AL

Bass Resonance 30/38 c/s.
Flux Density 17,000 gauss.
Total Flux 190,000 maxwells.



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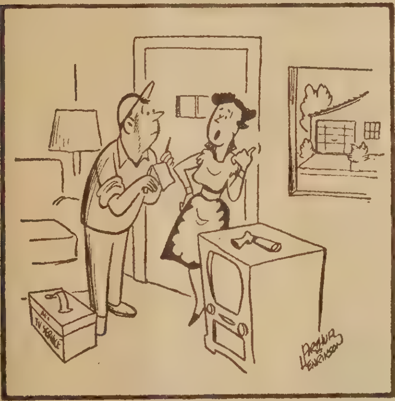
FROM THE SERVICEMAN WHO TELLS

When a TV set develops synchronising faults the trouble may be in any one of a number of stages. I have two such faults this month, both somewhat unusual, plus a story of how an amateur serviceman was trapped by an elementary fault in an amplifier.

THE first case involved a well-known commercial receiver and the owner complained that the picture was "very unsteady." A little gentle questioning revealed that this was evident in both directions, i.e., horizontal and vertical. In the vertical sense the picture had a tendency to "flip" or roll, particularly when there was a sudden change of scene brightness, while, horizontally, there was severe "pulling," again dependent on picture content.

From this it was reasonable to assume that, whatever the nature of the trouble in detail, it almost certainly involved the synch pulses and some part of the circuit common to both vertical and horizontal pulses. This is distinct from the condition where synch is lost in one direction only and which usually — though not always — suggests trouble in the relevant oscillator circuit or separate synch amplifier where these are used.



"The TV set's OK — but our neighbour's garage door opens when I use the remote control!"

(I say not always, because it can happen that reduced synch pulse amplitude will affect one section before the other, depending on which is most sensitive to this defect.)

VARIETY OF CAUSES

Lack of synch pulse amplitude can be due to a wide variety of causes, including the tuner, IF strip, viedo amplifier, synch separator, and AGC system. In the tuner and IF strip, any condition which permits a valve to be driven into the distortion region its Eg-Ip characteristic curve will almost certainly result in unwanted synch clipping, often to the point where there is only a small portion of the synch pulse left.

This condition can be due, in turn, to a number of causes. Too much signal is sufficient in some cases, particularly where the AGC system is one of the simpler arrangements. A sick valve will have much the same effect even on moderate signals, since it will be driven into overload much sooner than it should. A circuit fault resulting in reduced plate or screen voltage can have a similar effect.

Similarly, a faulty AGC circuit can upset the operating conditions of these stages in such a way that they are overloaded at normal signal strength.

Most of what has already been said — with the exception of the AGC reference — will apply also to the video amplifier. A faulty valve or faulty operating conditions can result in the synch pulses being severely limited in amplitude.

SYNCH SEPARATOR

The synch separator is also a likely culprit. Fed with positive going synch pulses it uses the grid current so produced to produce grid bias; an arrangement which automatically clamps the peak level of synch pulses at approximately the same voltage regardless of signal strength. That done it is only a matter of adjusting the valve's operating conditions, by means of the plate voltage (and screen if any) until only the synch pulses allow plate current to flow. Thus the video is suppressed and the synch pulses passed on to their respective oscillator circuits.

That is, unless something goes wrong. If the synch separator valve characteristics or operating conditions should change, then we may get either video along with the synch pulses, or very much reduced synch pulse amplitude. Either way, the synch system will misbehave and will usually show some sensitivity to video content. Even though the actual level of video in the plate circuit (normally small) may not have increased, the fact that the synch pulse has decreased will upset the proportion between the two and make the following circuits video sensitive.

A LITTLE THEORY

If I seem to have strayed a little from my original story, it is because I feel that it will help to set the scene if we consider some of the likely possibilities in a case like this. Coming back to the actual set, the symptoms were, as I said before, indicative of depressed synch pulses. More than that it was impossible to say until I could examine the chassis in detail and, ideally, check the appropriate wave forms on the CRO. To this end I arranged for the chassis to be brought back to the shop where these tests could be made.

On test there was no doubt that something was wrong. The picture would flip and tear at the slightest provocation, and I imagined that a fault as bad as this must be something obvious. Instead, it turned out to be quite a tricky one, and certainly nothing like anything normally found in the textbooks.

My first check point was the output of the video amplifier. This is a convenient place to start, moving towards the detector if a fault is evident, or towards the synch separator if all is well thus far. In this case the waveform seemed normal at this point, thereby eliminating all the front-end sections of the receiver, and considerably narrowing the field. This much at least was hopeful.

The synch separator was the triode portion of a 6U8, coupled to the plate of the video amplifier through a conventional isolating resistor, coupling capacitor, and time constant network. Shifting the CRO lead to the grid of this valve revealed a virtually identical waveform, thus eliminating these few components.

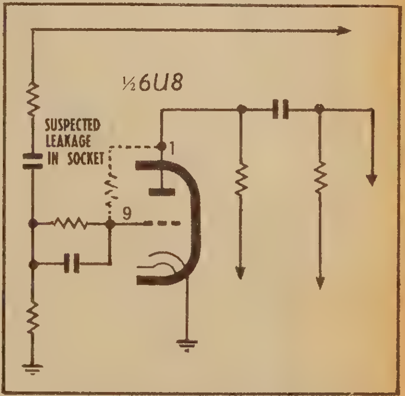
The next check was at the plate of the synch separator. If this stage was at fault I expected it to show up either as seriously attenuated synch pulses or more nearly normal pulses with an abnormally high video content remaining.

In fact, the latter turned out to be the case and, with this much established, I began a careful check of the stage to find out why.

ROUTINE CHECK

Was it the valve? I checked this in the tester, where it showed "GOOD," then replaced it with a known good one, which behaved in exactly the same manner. So that test proved negative.

Next the operating conditions, particularly as governed by the associated components, plate and grid resistor, etc. Testing each component individually revealed nothing abnormal and, with a normal HT supply, seemed to indicate one of those cases where there is (apparently) nothing wrong except that the thing won't work.



The synch separator section of the TV set, showing the leakage across the valve socket which upset its operating conditions.

My first clue occurred more or less accidentally. I happened to glance at the CRO screen (the lead was still connected to the plate of the synch separator) while the synch separator valve was out of its socket, and was surprised to observe a substantial level of signal still present.

Since the pins concerned, 1 (plate) and

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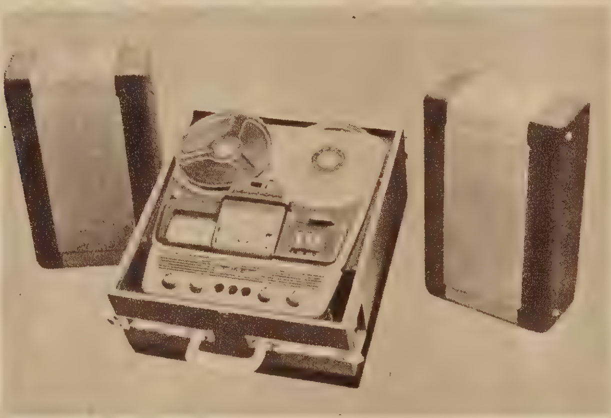

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9 (grid), are adjacent, I immediately wondered whether there was some form of leakage between them. A visual inspection of the socket revealed nothing, so I disconnected the leads from both pins and checked the resistance between them with the highest ohms range of the VTVM. This also proved negative.

Finally, more or less as an afterthought, I squirted some contact cleaning fluid into the space between the two layers of punching material, and around the underside of the socket in general. Then I put the valve back in its socket and tried again.

SUCCESS!

And, lo and behold, the trouble had vanished. I made a careful check of performance over a period of several hours without a sign of pulling or rolling — something which would have been quite impossible previously — and also checked the waveform at the output of the synch separator. This also appeared to be free from spurious video. Finally, just to be on the safe side, I changed the socket.

That was many weeks ago, and a recent check with the owner confirmed that there had been no recurrence of the trouble.

As to the exact cause, I'm afraid that must remain a mystery. A more detailed examination of the discarded socket failed to reveal anything abnormal, so I can only assume that, if it was due to foreign matter, this was completely dissolved by the cleaning fluid.

Since there apparently was a leakage path of some kind, which was not capable of being measured, the most likely explanation appears to be that the leakage became evident only when sufficient voltage was present between plate and grid.

Rather more important is the exact effect that such a leakage is likely to have. While the seemingly most obvious one might be simply that of signal leakage across the pins (which undoubtedly was occurring) it is far more likely that the main effect was to upset the rather delicate bias condition at the synch separator grid. Positive voltage at the plate, leaking across to the grid, would cause the synch separator to conduct not only during the peak voltage periods of the positive-going synch pulses, but also for substantially lower values, representing the video information. Hence, unwanted video mixed with the synch pulses.

As I said at the beginning, one is unlikely to find that kind of fault in a textbook.

HOME-MADE SET

My second synch story is rather different. It concerns a home-made receiver, built from the R., TV and H. of August, 1959, and which the owner had just completed. He approached me to have the job aligned and, while I usually try to steer clear of such jobs, there was no easy way to avoid this one. For one thing, the owner had been a good customer in the past and seemed reasonably bright in matters electronic. Furthermore he had made a good job of the set, obvious attention having been given to neat wiring and correct layout, and it seemed rather churlish to refuse.

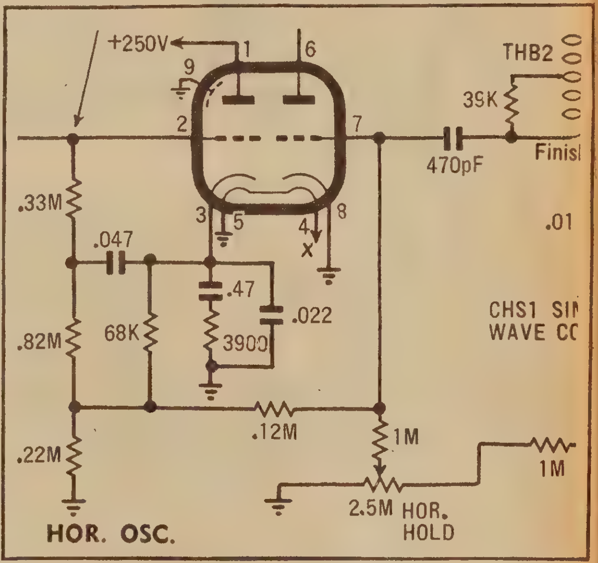
So I consented to tackle the job on the understanding that, at the first sign of instability, I reserved the right to ditch it if the cause was not readily obvious. The owner agreed, and so I set to work.

As it turned out, I needn't have worried on that score. The strip lined up "copy-book" fashion without a hint of trouble, suggesting that the original design was a basically sound one, requiring only that it be correctly assembled and wired in order to perform as was intended.

Having completed this much I connected an aerial and gave it an "on the air" trial. After the normal routine adjustments were made the picture was brought into synch, adjusted for height, width, and linearity, etc., and generally made presentable. At first, I imagined that all was well, since the picture was sharp, the sound clear, and everything seemed to be going along nicely.

CRANKY SYNCH

Then I realised that the horizontal synch was rather cranky, the hold control having a much narrower range of adjustment than normal for this kind of circuit, and also that the picture was prone to tear with quite mild bursts of electrical interference. Since this, also, is foreign to this type of circuit, or indeed to any good AFC system, it was obvious something was not as it should be.



The AFC section of the 1959 R., TV & H. TV receiver, showing (dotted) the .47 mfd capacitor which the constructor omitted. The result was a very touchy horizontal oscillator system.

Once again I went over the relevant circuits with the CRO on the lookout for compressed synch pulses, etc., but found nothing. The synch pulses appeared to be perfectly normal in amplitude and "clean" in regard to spurious video. This, coupled with the fact that the vertical synch seemed normal, suggested that the trouble might be in the horizontal oscillator or associated circuitry.

Sure enough, a routine check around the 6CG7 blocking oscillator/synchroguide circuit revealed the fault; a .47 mfd capacitor which forms part of the time constant network in the cathode circuit was conspicuous by its absence. This kind of fault is not unusual with a new chassis, it being very easy to overlook a component in spite of the most careful checking. On the other hand, of course, exactly the same symptoms would occur in an otherwise good set if the same capacitor suddenly developed an open circuit.

It is interesting to reflect on the effect which the absence of such capacitance will have on this circuit. The 6CG7 valve performs two functions. The first triode (pins 1, 2 and 3) functions as a control valve, and the second (pins 6, 7 and 8) as a blocking oscillator at the line frequency (15,625 c/s.).

The control valve's job is to compare synch pulses from the synch separator with pulses from the horizontal oscillator and to develop a control voltage indicative of the phase shift between the two. The two signals to be compared are applied to the grid and (in simple language) produce pulses of plate current having a duration dependent on the degree to which they coincide.

The pulses of plate current flow through a resistor in the cathode circuit and develop a voltage across it, a fairly large value of capacitance being used to filter this into a steady DC voltage. This voltage then becomes the control voltage which is applied to the grid of the blocking oscillator to control its frequency. (One of the characteristics of the blocking oscillator is the ease with which this can be done.)

As you've probably guessed, the filter capacitor referred to above was the one that was missing in the set on the bench. Since there are other, smaller values of capacitance in the cathode circuit, the system still worked, but the time constant was far too short to give the stability normally expected from it. In fact, it probably was behaving more like the old-fashioned direct synchronising system, whereby each horizontal synch pulse triggered its particular line, and which could occur early or late according to a number of factors, particularly noise.

DRAMATIC CURE

Just how important is this capacitor was demonstrated quite dramatically when I fitted it into the chassis under discussion. The horizontal control range returned to normal and the extreme sensitivity to electrical interference vanished.

The customer was mildly chagrined when I told him what he'd done, but added that he supposed ". . . one fault in a bloke's first TV set wasn't too bad.".

I agreed that it wasn't, and he departed in high spirits with the chassis tucked ever so carefully in the boot of his car.

Another home builder who sought my aid recently managed to get himself in a

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rather unusual mental tangle. His problem concerned an amplifier, apparently owned by a friend, which had failed completely and which he had attempted to repair. In fact, he believed he had found the fault and passed the job over to me only because he needed a special component and found himself unable to spare the time to locate and fit it.

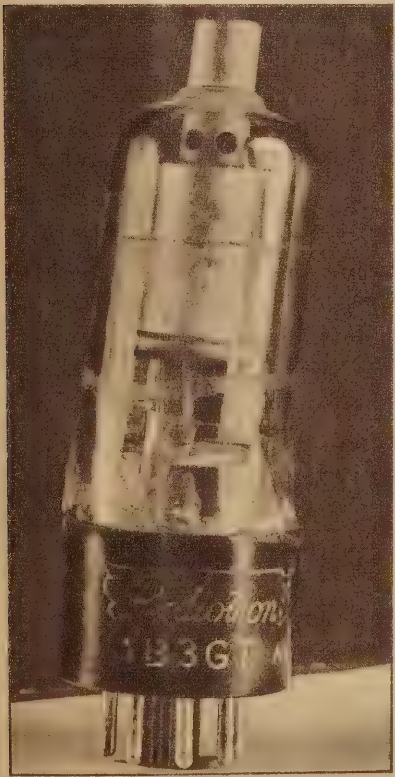
It was a Williamson type amplifier and, according to our friend, the power transformer had broken down from one side of the HT winding to chassis. He had, in fact, clearly marked the relevant pin on the rectifier socket, so that there could be no mistake. In addition, the state of the power transformer told its own story; a faint smell of toasted varnish, discoloured paintwork, and all the usual symptoms of a very severe overload.

So, as far as diagnosis was concerned there seemed to be no problem. What was worrying him was that he had been unable to purchase a suitable replacement transformer over the counter, plus the fact that he suddenly found himself short of time in which to finish the job. As a result, he passed the whole thing over to me with the request that I obtain a replacement transformer and fit it for him.

STRAIGHTFORWARD?

Well, that seemed straightforward enough, particularly as he appeared to have done most of the hard work already. And, taking him at his word I was about to order a new transformer, when it occurred to me that it might be just as well to check his diagnosis.

Lifting all HT leads from the remainder of the circuit I checked for a breakdown to chassis, but failed to reveal any sign of such a fault. Thinking that it might occur only with the full voltage applied, or that it might be a shorted turn, I disconnected all the heater circuits, so that it would run under true "no load" conditions, and plugged it into the mains.



Believe it or not, but this is how one customer tried to "repair" a broken 1B3 rectifier. Unfortunately, he omitted to replace the missing vacuum!

Contrary to what I expected, there was no smoke, fireworks, or other signs of distress and, even after it had run for half an hour, there was only a very slight rise in temperature. In short, there appeared to be nothing wrong with the transformer as far as I could tell.

But if the transformer was OK, then what had failed and why the signs of overload already mentioned? Well, that was what I had to find out.

My first check point was the HT line. The ohm meter indicated a resistance of only a few ohms, suggesting that the fault was quite different from what our friend had suggested. It also explained why the power transformer showed signs of overload, even though there was nothing wrong with the unit itself.

Before going any further in regard to actual HT short I plugged the rectifier into the tester. Sure enough, it was completely dead. It seemed a fair assumption that its failure had saved the power transformer, by acting in the manner of a fuse, even though a rather sluggish — and expensive —one.

That much established I set about finding the actual short. And, by lifting a few HT leads and isolating various sections I was soon on the track — in the vicinity of the output transformer. Finally, with all the leads to this component disconnected, I was able to measure a short between the centre tap and chassis.

Further investigation showed that one side of the primary winding was open circuit and this, presumably, was the side that was shorted to frame. Now, of course, the whole picture was perfectly clear. The output transformer primary had shorted to frame, overloaded the HT system, and caused the power transformer to get rather hot under the collar. Then the rectifier packed up and saved it from further punishment.

WHY THE ERROR?

The remaining question was, how did our would-be serviceman come to imagine that it was the power transformer which was at fault? Well that's simple, really. The power transformer looked as though it had failed, so it was the first thing he tested. And when the ohm meter showed only a few ohms between one rectifier pin and chassis he considered the point proved. The only catch was that he had omitted to disconnect the centre tap from the chassis and the reading was, in fact, perfectly normal.

So it was just as well I checked before I ordered a new power transformer.

Regular readers may remember how, a few years ago, I made something of a sideline of collecting and re-telling odd stories about non-technical types who attempt to repair their radio set. Some of these were pretty colourful, including one type who packed wads of newspaper behind the speaker cone to cure a bad case of hum (actually due to an open circuit electro.) and another who "lubricated" a rattling loudspeaker with office glue. This worked surprisingly well — until the glue set overnight!)

More recently, it seemed that these stories belonged to a past era — nobody seemed to butcher things any more and I began to wonder whether the public was, after all, becoming educated in such matters.

Alas for such hopes. I recently had occasion to service a set in which, according to the owner, there was no sign of a picture of any kind. Was there any sound? Oh yes, plenty of sound. Was there any raster? (This had to be translated into "light," since few people are familiar with the more technical term.) No, there wasn't any light on the screen, no picture at all in fact.

When I finally examined the set I found it as the owner had described; plenty of sound but not a glimmer of anything on the screen. Unhooking the EHT lead I quickly established that there was no EHT, and from there I moved to the EHT cage.

There was nothing tricky about the fault: simply a defunct 1B3 EHT rectifier, and I had a new one in the socket and a picture on the screen in a matter of minutes.

CRACKED ENVELOPE

But what really had me in was the nature of the fault. The glass of the valve had cracked around the full circumference in an almost straight line about half an inch up from the base. How or why, I have no means of knowing, but it was obvious that someone had been aware of the fault before I was called.

How do I know? Simple; they had tried to repair it with transparent sticky tape! They hadn't made a bad job in one sense, in that the two sections of glass had been carefully matched up and precisely joined. The only thing they had failed to do was restore the missing vacuum; a not very obvious but highly important part of such components.

Sensing a story I made discreet inquiries as to how the valve came to be in such a condition. But it was no use; I might just as well have inquired from a group of schoolboys who put the cricket ball through the headmaster's window. It was obvious that someone knew the answer, but equally obvious that no one was prepared to talk. Since the customer is always right I naturally didn't press the point, but I did pocket the evidence to illustrate this story.

Unfortunately, in getting the valve out of its socket, and in subsequent handling the two sections of glass became more obviously separated, so that, by the time I was able to photograph the contraption, it was not quite as I found it. Nevertheless, the picture gives a good idea of the lengths to which people will go to avoid a service call.

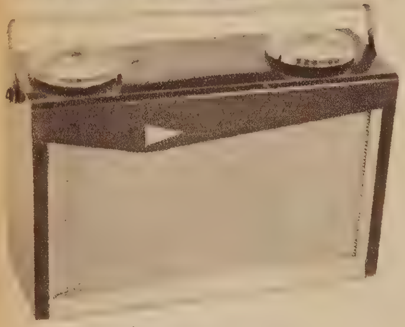
ANOTHER VACUUM STORY

Mention of vacuum a few paragraphs back reminded me of another story. Years ago when I worked in a factory, a fellow worker had the misfortune to drop a valve and break it, completely shattering the entire envelope and leaving the elements standing naked on the base.

In order to secure a replacement he had to return the valve to the store, suitably tagged for identification and stating the nature of the fault.

And in the space provided for this latter information he carefully wrote, "Poor vacuum!"

MAKING A TRANSISTOR PORTABLE?



TRANSPORTA 4

Complete Kit of Parts for Transporta Four as featured in October Radio and Hobbies, including Cabinet as used with the Transporta.

£16-17-6

LESS CABINET, £14/7/6.

Most parts used in the Transporta Four can be used for the Transporta Seven should a larger set be required at a later date.

COMPLETE KIT OF PARTS for the TRANSPORTA SEVEN

£25/17/6 SET WIRED AND TESTED £2/10/- EXTRA

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These new 4-speed Record Players are supplied with turnover crystal pick-up and sapphire needles, and are suitable for use with the above or any transistor radio.

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NEW TAPE DECKS

ENGLISH TAPE DECKS, 3-SPEED PUSH BUTTON CONTROL. SHOP SOILED.

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NEW 12in PER MAG SPEAKERS

These Standard Speakers by leading manufacturer (we cannot advertise the make) are supplied less transformer.

47/6 Packing extra. Post, N.S.W. 10/-; Interstate 12/6.

9in x 6in OVAL SPEAKERS

37/6 Post, N.S.W. 7/6; Interstate 11/6. Plus packing.

Transformers for above speakers 5,000 or 7,000 ohms, 10/-.

BATTERY CHARGER RECTIFIERS

New Selenium Rectifiers, 6 or 12 volt, at 4 amp, 37/6.

Post, N.S.W. 7/6; interstate 10/-.

Transformer for above rectifier tapped for 6 or 12 volt, with circuit for charger. 47/6

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New Collaro Tape Recorder Motors, 240 volt, A.C. Adaptable for many uses. **37/6** Post extra.

CONDENSER SPECIALS

Boxes of 100 new ceramic, mica, paper and electrolytic condensers in values ranging from 50pf mica to 5 400v paper. Values include .0001, .00025, .00075, .02, .05, 1. Also 500 mfd/12v., 8 mfd 525v., 16 mfd/350v., electrolytics.

25/- per 100.

Post Extra: N.S.W., 2/6; Int., 3/6.

CONDENSER SPECIALS

100 new mica paper and ceramic condensers, mixed values.

15/- Post 2/.

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I.R.C. carbon resistors, ½, 1 and 2 watt, in values 5 ohms to 5 meg., including many popular sizes. 3T, 15T, 20T, 50T, 100T, 250T, 500T, etc.

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New Dubilier pigtail condensers,

8mfd 525v	2/9
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Post Extra

TV OR AMPLIFIER POWER TRANSFORMER

240v pri., sec. 260 x 260, 250mA. 6.3 v windings.

£3/15/0 F.O.R.

(Too heavy for post.)

80 mA TRANSFORMER

240v pri., sec. 285 x 285, two 6.3v fil. windings.

32/6

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60mA prim.: 240v with 230v tapping. Sec. 285 x 285 with 6.3v filament winding 60mA.

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with SWITCH STANDARD SPINDLE	WITH SWITCH SHORT SPINDLE	LESS SWITCH STANDARD SPINDLE	LESS SWITCH SHORT SPINDLE
25,000 ohms 100,000 ohms 500,000 ohms	600 ohms w.w. I.R.C., 7/6 100,000 ohms. 500,000 ohms.	100,000 ohms. 500,000 ohms. 500 ohms. 5,000 ohms.	50,000 ohms. 100,000 ohms. 500,000 ohms.
5/6 ea. 50/- doz.	2/6 ea. 24/ doz.	3/6 ea. 33/- doz.	1/9 ea. 16/ doz.

25,000 ohm screwdriver adjustment, 1/9.

500,000 ohm pots can be supplied tapped at 40,000 if required, post extra.

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New 5 Valve Dual - Wave Radiogram Chassis

THESE NEW DUAL WAVE RADIOGRAM CHASSIS MADE BY LEADING MANUFACTURER ARE EQUIPPED WITH LATEST MINIATURE VALVES AND SUPPLIED WITH 12in ROLA SPEAKER. PACKING 10/- EXTRA

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THESE NEW 4 SPEED RECORD CHANGERS ARE EQUIPPED WITH HIGH FIDELITY CRYSTAL PICK-UP AND SAPPHIRE NEEDLES. CAN ALSO BE USED AS A MANUAL PLAYER.
SUITABLE FOR USE WITH ABOVE RADIOGRAM CHASSIS. F.O.R. **£10/15/-**

DUAL CONCENTRIC SWITCH POTENTIOMETERS

500,000 ohms plus 10,000 ohms, also 500,000 ohms plus 1 megohm. Long spindle.

10/-
POST FREE.

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5T or 7T Trans.

25/-
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STANDARD INTERMEDIATE FREQUENCY TRANSFORMERS

455Kc, 1¼in square cans. Slug tune. 4/9 post extra.

GARRARD RECORD CHANGERS 3-SPEED 32 V.D.C.

New English Garrard Record Changers fitted with high fidelity turn-over Crystal Pick-up, Sapphire Needles. For 32-volt D.C. operation. Can be used on any D.C. voltage exceeding 32V with External Resistance.

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NEW 4-SPEED PLAYERS

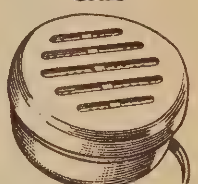
With turnover Crystal Pickup

£8 POST N.S.W., 7/6. INTERSTATE, 12/-

NEW STEREO CHANGER, 4-SPEED. F.O.R. £17/10/-

NEW 4-SPEED STEREO PLAYER, £10/10/- F.O.R.

PILLO-FONE EXTENSION UNIT



IT'S A REAL MINIATURE WITH ROLA UNIT

Install it anywhere, in the sick room, workshop, garage or any room in the house. Just connect across voice coil of the existing speaker. The "PILLO-FONE" IS THE MOST CONVENIENT LITTLE UNIT YET DEVISED. 3½in Diameter by 1¾in deep.
POST FREE. **22/6**

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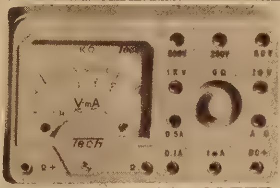
As featured in April issue of R. and H. including TWO ROLA 8MX SPEAKERS. Parts include chassis and case. FERGUSON OUTPUT TRANSFORMERS, VALVES and all necessary parts.

£32/10/ f.o.r.



SUPPLIED COMPLETE WITH TEST LEADS

NEW MULTIMETERS – 61/- POST EXTRA

METER 0-1mA 1000 OHMS PER VOLT

A.C. RANGES	D.C. RANGES	CURRENT RANGES
0—10v	0—10v	0—1MA
0—50v	0—50v	0—100MA
0—250v	0—250v	0—500MA
0—500v	0—500v	
0—1000v	0—1000v	

OHMS RANGE 0-100,000 OHMS.

NEW VALVES AT BARGAIN PRICES

6J6	12/
ECH 35/VR99A, Direct replacement for 6J8G	10/
1C4	7/6
1T4	4/6
3S4	10/
1R5	10/6
1A7GT	9/6
1D8GT	9/6
6A8G	10/6
6AC7	3/6
6K8G	6/9
6SJ7GT	9/6
12K8	10/
EK32	6/9
6SA7GT	9/6
6SH7	5/6
105G	4/
1P5G	2/6
1C7G	3/
1K5G	2/6
1M5G	3/
1K7G	3/
1L5	9/6
6C8G	5/
6SS7	8/6
6H6	2/6
6SL7	10/6
6H6GT	2/6
6K7GT	7/9
6U7G	5/
6J7G	5/
7C7	3/6
78	7/6
EL32	10/6
6B6G VR55	5/
6V6GT	12/6
VR65A	2/6
41	7/6
7193	2/
12A6	7/6
EF50	2/6
12SH7	5/
6K7G	4/6
1C6	7/6
955	2/6
954	2/6

SPECIAL PRICES FOR QUANTITIES.
Please add postage on all valves.

NEW VALVE SOCKETS: Ceramic EF50 sockets, 2/6 ea. American moulded Loctal, 1/ ea. Octal 8-pin wafer, 6/6 doz. 5BP1 socket Ceramic, 7/6. Amphenol 5-pin ceramic, 2/6 ea. All post extra.

NEW MINIATURE COILS and I.F. TRANSFORMERS: Aerial, R.F. or Oscillator Coils, 7/6 ea. Post 1/-. I.F. Transformers, 9/6. Post 1/-. Short Wave Coils, 16 to 49 metres, 5/6 ea.

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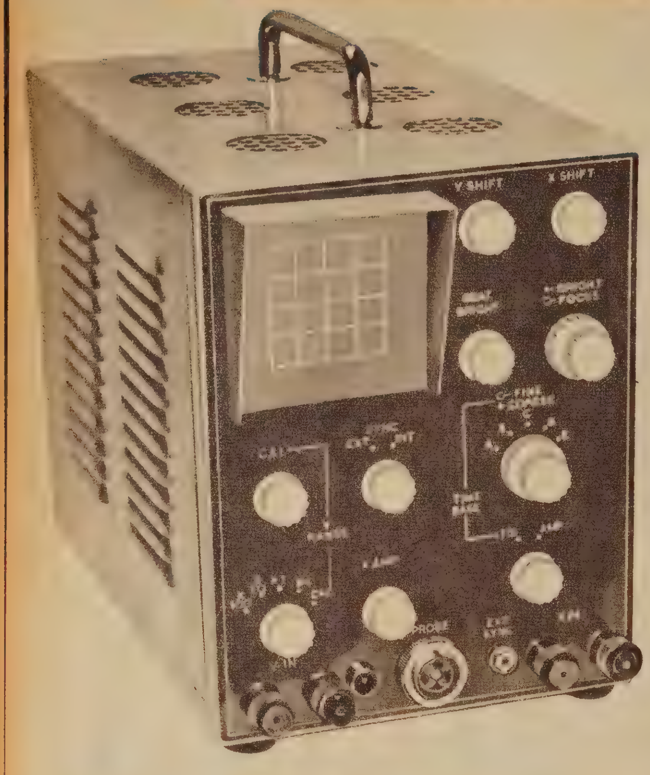
High Performance 3inch CRO

The oscilloscope described here is designed to meet the need for an adequate but not over-elaborate transportable general service instrument, and features a new miniature CRO tube, specially designed for this type of instrument.

By John Barker and Brian Cleaves



The finished CRO is a compact attractive instrument measuring only 11¼in deep, 9in high, and 7in wide. It is light enough to be called "portable." Note the concentric controls for brightness, focus, and the two time base functions.

DURING the past 10 years or so, all the oscilloscopes we have described have utilised disposals type cathode ray tubes. Primarily this was done because these tubes were plentiful and cheap—and a five-inch tube, similar to the ones we have used, can cost well over £10 when purchased through normal trade channels. Better-class five-inch tubes can cost upwards of £30.

LIMITATIONS

As one may fairly expect (at the prices) the more common disposals tubes have certain limitations which must be taken into consideration when instruments are planned around them. The sensitivities are generally rather low and they require high EHT voltages to ensure a clean, easily focused trace with acceptable brightness. Also inter-electrode capacities are inclined to be higher than desirable in some cases.

In all of our more ambitious instruments to date we have overcome these problems in such a manner as to make the use of these cheaper tubes really worthwhile—provided one is prepared for a rather bulky instrument with a heavy power transformer and large EHT supply.

One case in point is the Wide Band CRO, which was described in 1957. This used a disposals 5BP1. The ultimate deflection sensitivity is about 180 mV in, and the vertical amplifier response level from 1 c/s to over 3 mc/s, which performance is more than adequate for TV service work. Some improvement would be possible with the use of a more sensitive CRO tube but it would increase the already considerable cost by at least £10 or £15 and it may be considered not worthwhile.

A somewhat less ambitious project was the New Standard Oscilloscope of June, 1960. This was not so much a new design but rather a means of modernising older CRO's which were built in the pre-television era. Its performance was not as good as the Wide Band CRO but it was still definitely good enough for average TV servicing and, in fact, we have used some of its circuitry in the present instrument, as is explained later. It also uses a 5BP1.

A five-inch CRO of this size is essentially a laboratory instrument in the sense that one must take equipment to be tested to it, rather than carry the CRO to the equipment.

This is not really a problem with the usual run of amplifiers, receivers, test instruments, etc., because they are not too bulky, and the nature of the usual tests and repairs are such that an oscilloscope is not very frequently required.

With television, however, we have a different story. Here the oscilloscope becomes almost as important as a multimeter is to the radio serviceman. The nature of the beast is such that after most of the simple tests have failed to reveal a fault, it becomes almost essential to be able to examine various waveforms in order to speed up servicing.

PRACTICAL PROBLEMS

Now if TV sets were about one-quarter as bulky, and if owners were only half as worried about seeing their sets carted away to the repair shop, as they are, and if repair men had unlimited time, then it would be quite in order to take all sets back to the shop where appropriate equipment is permanently set up. Unfortunately, this state of affairs does not exist.

What is really required, then, is a portable, compact CRO which will adequately reproduce all the waveforms likely to be needed for efficient servicing of TV receivers. We believe our new design possesses all the necessary features of such an instrument without being overly complicated or hard to build.

That is not to say that a larger instrument, permanently installed over the workbench, is no longer an advantage. It is obviously more convenient to have one CRO set up, in conjunction with sweep oscillator, etc., in a more or less permanent fashion for those jobs which require that the set in question be returned to the shop anyway. And for alignment purposes the larger screen is a definite help.

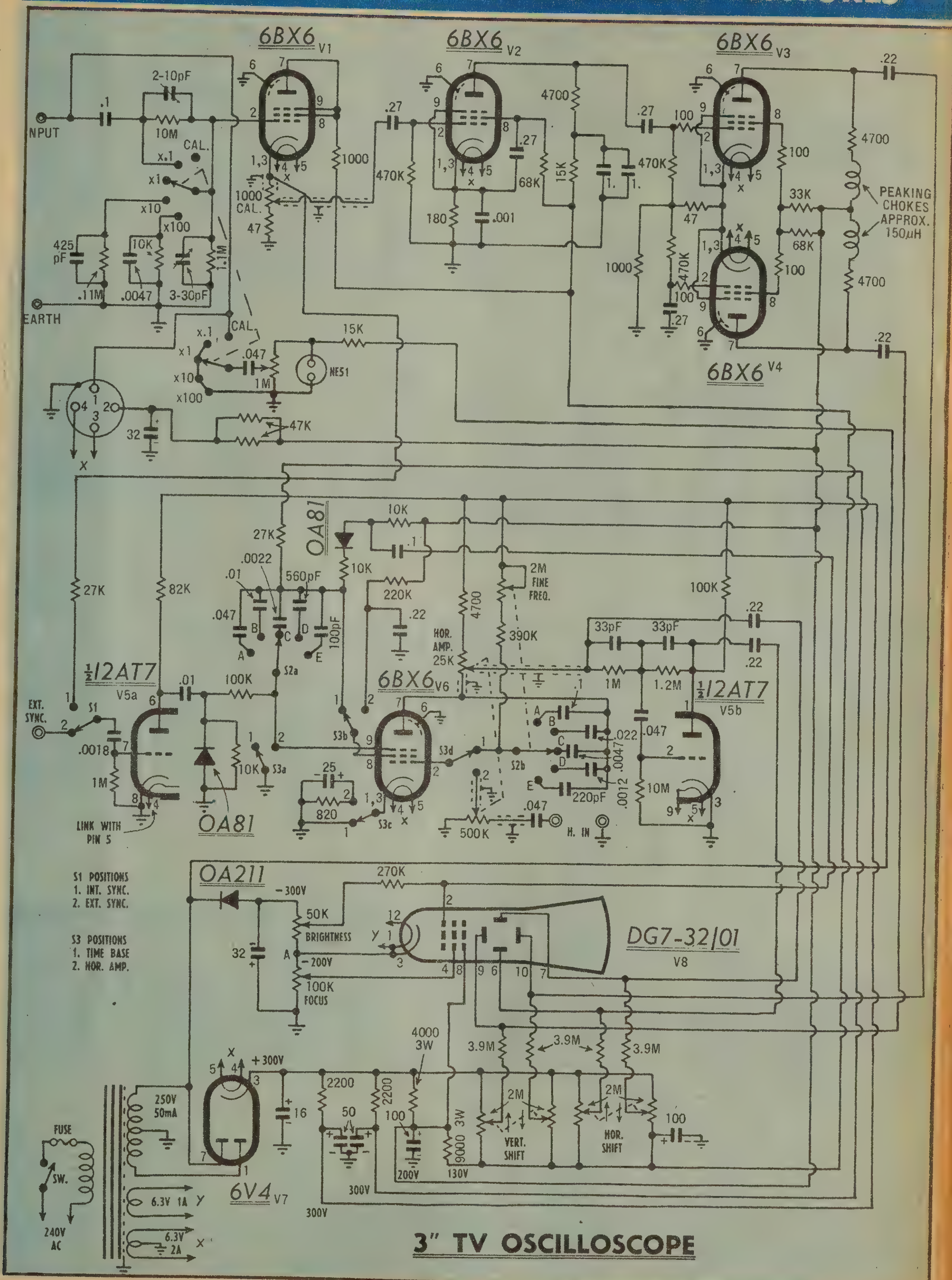
Whether we agree or not that the two instruments are a good idea, the final choice will probably depend on the financial situation. It is interesting to note anyway, that our two CROs — the New Standard Oscilloscope and our new small CRO, which are both adequate for normal servicing — can be built for the same price that one pays for one good commercial portable CRO.

FEATURES

Let us, then, consider some of the features of our new instrument.

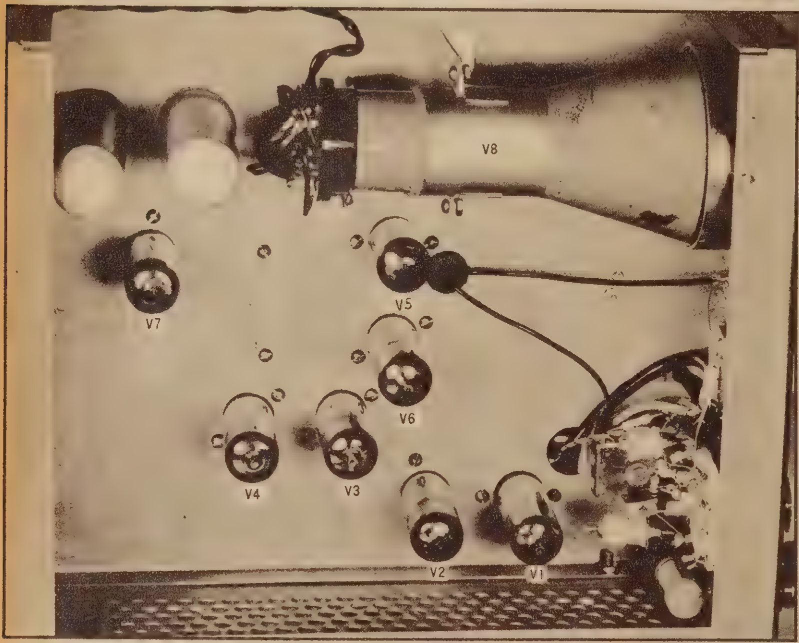
The first and most important point is the type of CRO tube to use. We had considered the use of one or other of the disposals tubes currently available. Such might be the 3in. 3AP1 or VCR138. They are available quite freely and only cost about 30/. However, an investigation of their more salient fea-

CIRCUIT IS SIMPLE — OFFERS MANY FEATURES


6BX6 V1
6BX6 V2
6BX6 V3
6BX6 V4
INPUT
EARTH
2-10pF
.1
10M
CAL.
x.1
x1
x10
x100
425 pF
.11M
10K
.0047
3-30pF
1.1M
1000
1000 CAL.
47
.27
470K
180
.001
68K
4700
15K
1.
470K
100
47
1000
.27
33K
68K
PEAKING CHOKES APPROX. 150µH
.22
15K
.047
1M
NE51
32
47K
27K
82K
27K
OA81
10K
.0022
.01
560pF
.047
100pF
220K
.22
2M FINE FREQ.
390K
HOR. AMP. 25K
100K
33pF
1M
1.2M
½12AT7 V5a
½12AT7 V5b
EXT. SYNC.
S1
.0018
1M
100K
10K
S3a
S3b
S3c
S3d
S2a
S2b
6BX6 V6
25
820
.022
.0047
.0012
220pF
.047
10M
500K
H. IN
LINK WITH PIN 5
OA81
S1 POSITIONS
1. INT. SYNC.
2. EXT. SYNC.
S3 POSITIONS
1. TIME BASE
2. HOR. AMP.
OA211
270K
-300V
50K BRIGHTNESS
-200V
100K FOCUS
DG7-32/01 V8
4000 3W
3.9M
2M
VERT. SHIFT
HOR. SHIFT
+300V
16
2200
50
100
9000 3W
200V
130V
300V
250V 50mA
FUSE
SW.
240V AC
6.3V 1A
6.3V 2A
6V4 V7
3" TV OSCILLOSCOPE

The finished circuit is relatively simple, yet offers a number of worthwhile features. The power supply is simple and economical by reason of the moderate EHT requirements. It uses a Miller transitron hard valve time base, and a tried and proven vertical amplifier with a response to better than 1 Mc. In addition, the time base is switched to function as a horizontal amplifier if required, while a simple clipping circuit provides a reference against which vertical deflection may be calibrated.

LAYOUT OF VALVES AND CRT



This is the equivalent of a "top-of-chassis" view in a conventional layout. It shows the placement of the major components, including the CR tube. Switch at lower right is the vertical sensitivity control.

tures shows that they are generally unsuitable for this application.

They are physically too big. Their sensitivity is too low; their inter-electrode capacities are large and they require EHT voltages of the order of 1,200 volts to ensure adequate brightness and good focusing.

Accordingly we then made some inquiries around the trade and discovered that the Philips Company have a new CRO tube, which was expressly designed for use in small service oscilloscopes. This is the DG7-32/01. It has a 2¾in. diameter screen which means that a pattern fully 1¾in. square may be accommodated. It is designed to operate with an EHT voltage of only 400 volts which simplifies the power supply design considerably.

SMALL AND SENSITIVE

It is only 6½in. long with a 12-pin duodecal base. Its small size makes it ideal for our purposes. Its deflection sensitivity in the "y" direction is roughly double that of the 3AP1 at 0.45 mm/volt, so that deflection amplifiers are correspondingly less complicated.

Finally, the new tube retails at around the £10 mark and the mu-metal shield is about £3 extra. This is quite a reasonable price when one considers the difficulty experienced in the past when trying to buy a good shield for other CRO tubes.

The final cost of the completed instrument should be within £50 assuming every component is bought new. Undoubtedly there are many constructors who will have most of the minor components, anyway — thank goodness for that old junk box.

So much for the CRO tube. Now, some further points about the overall performance of the instrument.

Ideally, for optimum reproduction of TV waveforms including square sync pulses, etc., the vertical amplifier response should extend beyond 5 or 6 Mc. In practice this is rather difficult to attain in an instrument in the lower price bracket. The main bugbear is the effect of stray capacitance which can drastically cut the upper frequency limit—but more of that problem later on.

The main thing is, that for practical servicing an upper limit of 1 or 2 Mc would seem to be quite adequate. There are some authorities who have said that 100 or so kc is an acceptable limit but we feel that this is perhaps too optimistic. Even with a response extending to about 1.5 Mc there will undoubtedly be some distortion of the steeper wave fronts, but a little experience on the part of the user will enable him to pick immediately, any unusual alterations or additions to the expected shapes.

Therefore we have aimed for that order of performance without making the adjustments too critical and the resultant response is flat from around 1 or 2 cps to 2.7 Mc. The response tails off beyond 2.7 Mc fairly gently so that distortion is minimised.

VOLTMETER FUNCTION

Another desirable feature is that the vertical amplifier is calibrated. This means that the peak-to-peak voltage of any observed waveform may be read directly from the screen.

Generally, manufacturers issue TV circuits with typical waveforms at various parts of the circuits and the voltages shown are peak-to-peak. If a VTVM is used to measure these voltages the reading is mostly valueless, if the waveform is not a pure sine wave, so that the calibration of the vertical amplifier is really essential in any self-respecting TV CRO.

The maximum vertical sensitivity of the vertical amplifier is 250 mV per inch. There is a four-step attenuator which changes the sensitivity by a factor of ten at each step. Therefore the maximum voltage that may be read is 250 volts peak-to-peak.

In order to read higher voltages than this it will be necessary to use a divider probe or two as the need arises. Two such probes may well consist of a ten-to-one and a 100-to-one divider. A probe socket is provided at the front panel and it is supplied with filament and HT voltages so that cathode follower and demodulator probes also may be used. We will have more to say about these later on.

A calibration source is contained in the instrument. It is a one-volt peak-to-peak square wave. It is used to set the attenuator accurately. The ultimate accuracy of the voltage measurement is about 10 per cent which is quite sufficient for normal TV work.

TIME BASE REQUIREMENTS

Again for TV work it will rarely be necessary to use a time-base frequency in excess of 20 kc. The line frequency is 15,625 kc and so long as the information in one line, including the sync pulses, can be observed clearly then that is sufficient. The range of the sweep in our CRO is from 20 c/s to 20 kc, in five switched steps.

If it is desired to use this CRO, in conjunction with a sweep and marker generator, for alignment purposes, then access to the horizontal amplifier will be required. Terminals are provided on the front panel and a two-position switch converts the sweep circuit into a normal amplifier with a sensitivity of 250 mV per inch.

Suitable sweep generators for this application have been described in our magazine in the issues of March and June, 1957, and May, 1960.

It will be seen in the front panel photograph that we have used two sets of concentric knobs. It is necessary to resort to this practice if the full range of controls is to be accommodated on a limited panel area.

The brilliance/focus assembly is a standard pair of concentric carbon pots which was available ex-stock. Something suitable for the fine/coarse, time base control, however, was not available and we had to "invent" the necessary assembly ourselves.

SPECIAL POT

The coarse control of sweep frequency is provided by a five-position switch whilst the fine control is a carbon pot. We, therefore, arranged with a manufacturer (Messrs. Ducon Industries Ltd.), to produce the pot. with an extension shaft protruding through the back cover. We then mounted the switch on a bracket at the back of the pot. and coupled it to the protruding pot. shaft with a flexible coupling. This can be seen in the photographs. The modified pot. should be available through normal trade channels in the near future.

At the time, the only concentric knobs available were those normally used on TV sets and in similar applications. We felt that these were a bit ornate for an essentially functional instrument and again had to "roll our own."

We bought standard knobs, with the design shown in the photographs, in two sizes, ¾in. diameter and 1in. diameter. We then carefully filed the top of the larger knob flat, until the diameter of the resultant flat circle was ¼in. At this point we found that we broke into the shaft hole moulded into the knob. The smaller knob sits over the flat on the back of the larger one and is screwed on to the inner shaft which protrudes through the hole in the large knob.

The inner shaft of the concentric controls is only 3/16in diameter. Most standard shafts on conventional pots, etc., are ¼in and knobs are made generally with a ¼in hole to match. Therefore a 3/16 to ¼in bush will be required for each of the concentric controls. These are available freely for a few pence but they could just as well be made up from some scrap aluminium.

EXTRA FEATURE

As will be seen from the front panel photograph, we have made provision for a control marked "Grat Bright." This is an extra feature which, though not strictly essential, is very handy at times. By means of this knob the brightness of the graticule lines may be varied to suit the external lighting conditions.

So much then, for the more or less external features of the instrument. We will now have something to say about the actual circuits themselves and about some of the problems likely to be met in their design.

The vertical amplifier is very similar to that used in the New Standard CRO The main difference lies in the fact that we have used 6BX6's rather than 6AC7's. They are a nine-pin miniature "noval" type with similar characteristics to the 6AC7. Since we are endeavouring to reduce the size of the instrument as much as possible, they are a natural choice. They are a television pentode and are freely available.

The first valve is connected as a cathode follower. At its input is a five position switch for the attenuator and calibrate control. Since this grid operates at a very high impedance the attenuator must be compensated so that its divider ratios are independent of frequency. That is the purpose of the small capacitors and trimmers across the resistors.

In the cathode circuit of this valve is the fine gain control which is used to set the calibration of the attenuator when the CRO is being used for exact measurements. When only the shape of the displayed wave is of interest, it is used in conjunction with the attenuator, simply to provide a conveniently sized pattern.

BASE BOOST

The second valve is a voltage amplifier with some degree of base boost arranged around the plate load. This helps to extend the base response by compensating for losses elsewhere. It is achieved by means of the split plate load and the 2 uF capacitor which is connected to ground. As the frequency drops, so the reactance of the capacitor rises and hence the gain also rises since this represents an increase in the effective plate load.

The last two 6BX6's are connected as a "long tailed pair." It is in this stage that the main high frequency compensation is carried out by means of shunt peaking chokes in the plate circuits.

In any amplifiers of this nature, the upper frequency limit is largely determined by the stray circuit capacitances which exist between the plate circuits and ground. They are made up of inter-electrode capacitances and those which exist between wiring and components and the earthed chassis. Together, they are equivalent to one single capacitor shunted across the load resistors.

One way of overcoming their effect is to connect a small inductor in series with the plate load resistors as shown in the main circuit diagram. This extra inductance forms, with the stray capacitance, a damped resonant circuit whose resonant frequency may be varied by varying the value of added inductance.

If the values of the added inductance and the plate load resistors are chosen correctly, then the high frequency response can be extended appreciably.

Regrettably we cannot go into the matter in any greater detail here but for those readers who require further information on the subject we suggest the issues of July and August, 1956, and those containing the Wide Range CRO (February to May, 1957).

However, the experimental work which we have carried out in our workshop has shown that a perfectly satisfactory result may be obtained in this instance by using standard 150 uH television peaking chokes. They are one of a preferred list produced for this purpose.

POWER SUPPLY

The power supply section is fairly simple. As may be seen, the amplifier HT is supplied by a conventional full wave circuit using a 6V4. In addition one half of the secondary winding is used, in a half wave circuit, to provide extra HT for the CRO tube. Here we have used a silicon type rectifier, the OA211. There are two filament windings, both 6.3 volts, one is for the amplifiers and supplies 2 amps. and the other is for the CRO tube and supplies 1 amp.

The output from the OA211 is negative by about 300 volts and the 6V4 cathode is positive by about the same amount, both with respect to earth. There is, therefore, a net 600 volts available between these two points.

A resistive divider is connected between the minus 300 volt point and earth so as to provide at its junction minus 200 volts. The CRO tube is connected between this point and plus 300 volts, giving a net EHT voltage of 500 volts. The upper part of the divider is used as a brightness control with the moving arm connected to the CRT grid. Thus the grid can be made up to 100 volts negative with respect to the cathode.

MINOR CHANGES

This circuit allows the use of a transformer which is standard in so far as voltages are concerned. However, for use in an oscilloscope, it is advisable that the flux leakage be kept to a minimum to avoid hum modulation of the CRT beam. Therefore this transformer was supplied with a copper strap which cancels stray leakage flux. In addition the manufacturers supplied four short mounting legs to suit the special chassis.

The time base generator is a Miller-transitron type which gives a high amplitude linear sweep. Very briefly, the generated frequency depends on the time constant of the 390 K resistor and the 2 meg. pot. and the capacitor selected by S2b, which is the coarse frequency control. The 2.0 meg. pot. provides a fine control of frequency between ranges selected by S2b.

PARTS LIST

1	Special box and chassis 11¼in x 9in x 7in with hood and panel.
1	power transformer 250v/250v, 50mA, 6.3v 3A., 6.3v 1A. Low radiation with mounting pillars.
1	Panel mount fuse holder. 2 ¼ x ¼ flexible couplings with bushes (see text). 1 4 pin shielded microphone socket.
1	CRT shield (mu metal).
2	150 uH chokes.

RESISTORS

½ W unless otherwise stated

2 27K, 2 1M, 1 82K, 3 10K, 2 100K, 1 220K, 2 4700, 1 390K, 1 1.2M, 1 10M, 2 15K, 1 180, 2 47, 1 1K, 2 47K, 3 470K, 1 270K, 1 820K, 2 68K, 4 100, 1 33K, 2 4700 1W, 2 2200, 4 3.9M, 1 10M Hi-Stab, 1 1.1M Hi-Stab, 1 10K Hi-Stab, 1 .11M Hi-Stab, 1 4000 3W, 1 9000 3W.

POTENTIOMETERS

1	50K (A) x 100K (A) x switch Dual Con.
1	25K (A) x 500K (C) Ganged. 2 2M (A) x 2M (A) Ganged.
1	2M (A) with special protruding inner shaft type PXA 002. 1 1M (A) (calibrate optional). 1 1000 ohm.

CAPACITORS

2 .1 mfd. 600v, 2 .0047 mfd. 400v, 4 .27 mfd. 400v, 5 .22 mfd. 400v, 2 1 mfd. 125v, 1 .001 mfd. 400v, 3 .047 mfd. 600v, 1 .047 mfd. 400v, 1 .01 mfd. 600v. 1 .01 mfd. 400v, 1 .02 mfd. 400v, 1 .0012 mfd. 400v, 1 .1 mfd. 400v, 1 .0022 mfd. 400v, 1 .0018 mfd. 400v, 1 560 pF silver mica, 1 100 pF silver mica, 2 33pF ceramic, 1 425 pF silver mica, 1 2-10 pF trimmer, 1 3-30 pF trimmer, 220 pF silver mica.

ELECTROLYTICS

2 50 mfd. 350v working, 2 100 mfd. 350v working, 2 32 mfd. 350v working, 1 16 mfd. 350v working, 1 25 mfd. 25v working.

SWITCHES

2 2 pole 5 pos., 1 12 contact blank (see text) 1 2 pole 2 pos., 1 5 pole 2 pos.

VALVES

5 6BX6, 1 12AT7, 1 6V4, 1 DG7-32/01 CRT, 1 50v neon (calibrate optional). 2 OA81 diodes, 1 OA211 diode.

SOCKETS

7 9 pin, 1 Duo-decal CRT (12 pin)

SUNDRIES

1 chrome handle, 1 3⅛in x 3⅛in green translucent perspex, 10 small knobs, 2 medium knobs (see text) 4 terminals, 1 pilot socket and bezel, 1 banana socket, 1 7 lug tagstrip, 7 5 lug tagstrips, 3 3 lug tagstrips, 1 2 lug tagstrip, mains cord and plug, grommets, nuts and bolts, h/u wire, etc.

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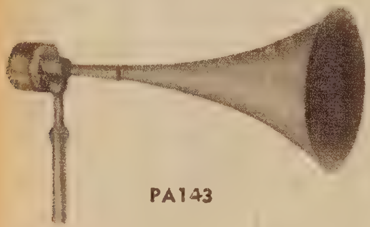

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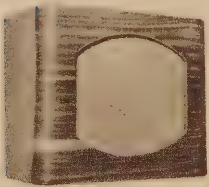

PA77/12PS
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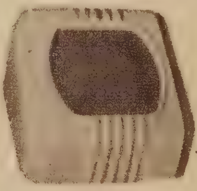

PA150/1
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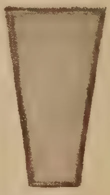

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PA188
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PA186
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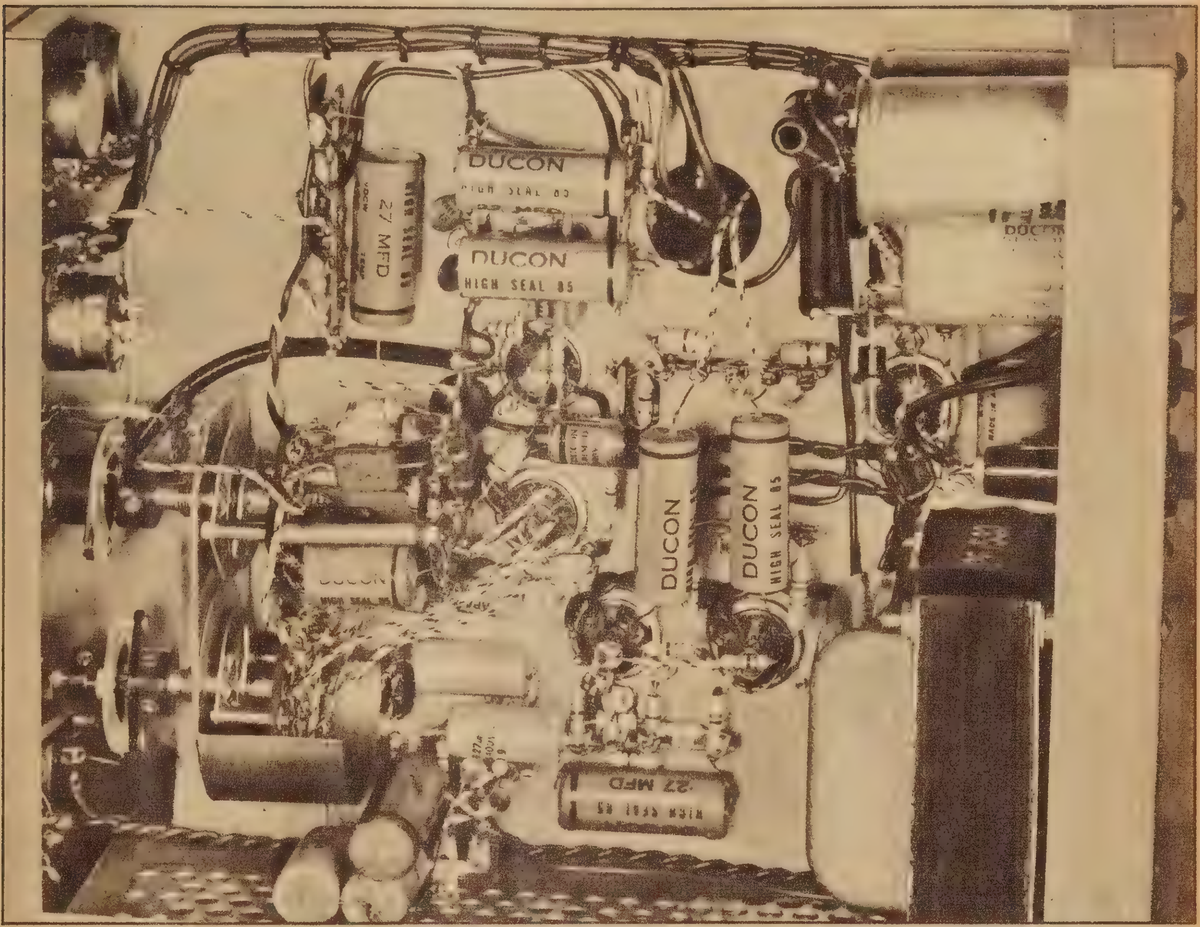

The power supply filter capacitors are mounted at the top right hand corner, below this can be seen the end of the fuse holder. Note the shield on the time base "X" amp. switch. Behind this is the cathode follower stage of the vertical amp. The special pot. with extended shaft can be seen associated with the time base switch at centre left. The components at top centre are associated with horizontal time base and phase inverter stages.

The capacitors selected by S2a determine the fly back time and the amplitude of the sweep voltage. They are chosen in this instance so that the amplitude is constant at about 150 volts on each range.

The Miller time base is capable of operating at very much higher frequencies than are required here, but since the CRO is primarily designed for TV work, there is no point is extending its maximum frequency beyond about 20 kc. A very good description of its operation is given in the article "A High Quality CRO Time Base," in the issue of September 1956.

The first half of the twin triode 12AT7 is used as a sync. amplifier and clipper and the other half is used as a phase inverter to provide a balanced deflection voltage for the CRO tube.

TIME BASE OR "X" AMP.

By means of switch S3 the time base generator is converted into an amplifier for horizontal deflection. There are four poles and their respective functions are; to earth the suppressor grid, to change the screen over to a normal bypassed series resistor, to change the control grid over to the horizontal input pot., and to switch in a bypassed cathode bias resistor. When functioning as an amplifier, this stage has a sensitivity of 250mV/inch.

The next consideration, then, is the physical layout. The three photographs accompanying the article are, to a large degree, self explanatory but we will point out some of the major components and suggest a proper orientation where it is not so obvious. Mostly, the layout of the minor components is not critical, except in one or two cases which will be mentioned and provided shielded leads are used where suggested.

LAYOUT

The "above chassis" view (which is in fact the left hand side of the vertical plate) shows the layout of the valves, the CRO tube, the attenuator and one or two of the other minor components. A small bracket, bent up from scrap aluminium, is bolted to the chassis and the CRT shield, and the CRT is held in place, in its shield, by pads of ¼in foam sponge.

The leads to the CRT socket are left longer than really necessary so that the CRT may be turned in its mounting to make the X axis horizontal. With our particular tube the X axis is correctly orientated when pin number 12 is uppermost with the oscilloscope standing upright.

Immediately behind the CRT socket are two chassis mounting electrolytics. They are the two 50 uF's, connected to the 2.2 K resistors which supply 300 volts to the sweep oscillator. Centrally below them is the 6V4 rectifier.

The remaining valves are labelled to correspond with the numbers of the circuit diagram. The attenuator components can be seen mounted on the back of the 2 x 5 switch. This may be wired separately and only the input, output and earth connections are needed when it is placed in the front panel.

In order to minimise the likelihood of earthloop trouble we have used only one common earth for the attenuator, the cathode follower and the calibrate pot. The attenuator is earthed to the "lid" of the cal. pot. and this in turn is earthed at the base of the cathode follower.

POT COVER

The cal. pot. which we have used is one wherein the lid is normally insulated from the earthed shaft. If you are using a pot. with an earthed lid you will have to lift this earth or use a tag strip to support the earth lead somewhere adjacent to the cal. pot.

Shielded cable, containing two conductors, is used for the connection between the cal. pot. and the cathode follower and it is the shield of this cable that is

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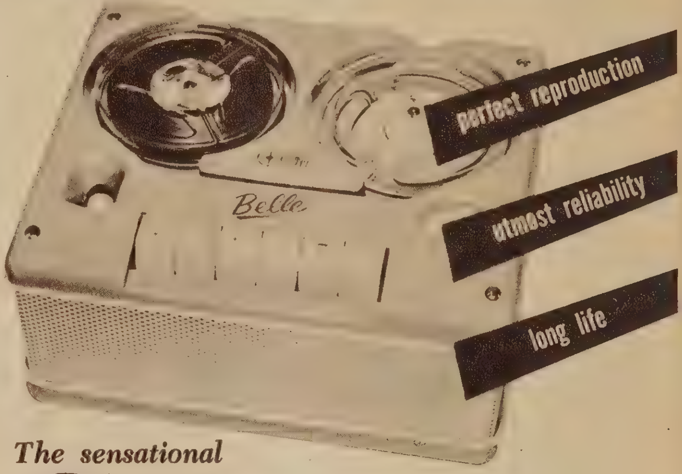

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the earth connection back to the valve base. This is the only piece of shielded cable used in the vertical amplifier and as it is used in a low impedance line its effect is not important.

Behind the attenuator, partly hidden by it, is the dual X Amp pot. The pot. furthest from the front panel is the one in the plate circuit of the sweep oscillator. This is the sweep width control. Shielded wire is again used to connect these pots to their respective destinations through the chassis. The twin shielded wire for the sweep width pot. passes through the chassis via a ¼in hole right next to the pots.

The other shielded lead (single conductor) connects the horizontal amp. gain control to the Amp./T.B. switch. It passes through the chassis via the ⅜in hole just above the valve V4. The grid lead from the attenuator also passes through this hole. This is a "hot" high impedance lead so it must be run well clear of the chassis. We have used tinned copper wire with spaghetti covering for such leads.

The Sync. switch is above the X amp. control with the 10 K resistor running directly to the Cal. pot. The lead from here to the grid of V5a, together with the HT lead for the sweep width pot, pass through a hole in the chassis near the base of V5.

WIRING

The filament leads for the CRT are brought through the chassis at the back of the rectifier, to a tag strip. A twisted pair of leads then connects to the CRT socket.

The "underside" of the chassis is much more crowded than the reverse side but is not unduly difficult if one approaches the matter of wiring logically.

Firstly bolt all the valve sockets in place. For the sake of easy orientation we will give the pin numbers which are uppermost in relation to our photo. They are: V1-2, V2-9, V3-6, V4-6, V5-2, V6-6, V7-9. All the tag strips may then be placed. If your chassis is cadmium plated, you will find it easiest to solder the tag strips to it. Otherwise they will have to be bolted.

Next, mount the transformer on its pillars and fit the major components of the power supply into place. The two electrolytics at the top of the chassis are the two 100 mfds. and just below them is the 32 mfd. connected to the OA211. To the right of the rectifier socket, against the chassis, is the 16 mfd. for the 6V4 cathode. There is a five-pin tag strip, for terminating the transformer primary taps, just behind the fuse on the back of the case. It is difficult to see in the photograph.

The OA211 is supported between the rectifier socket and a tag strip, and that just about completes the power supply.

The sweep speed switch can be wired separately in similar fashion to the attenuator. The capacitors are supported between the main switch wafer and a dummy (without a centre portion) which is separated from the main wafer by two 1½in spacers. This switch is then ready to be mounted when the amplifiers beneath it are completed.

The switch in the lower left section is the amp./T.B. switch around which is mounted a brass shield. The shield is arranged to pass between the switch and the vertical amplifier cathode follower which is just below it. It is made from two pieces of metal, one a disc, 2in in diameter, which fits concentrically onto the switch shaft, and the second, a piece, 3in by 1½in, which is bent into a semi-circle and soldered to the rim of the disc.

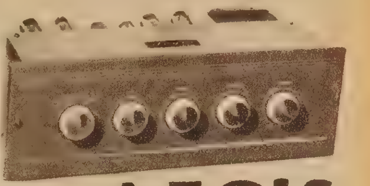
SWITCH MOUNTING

This shield can be fitted to the switch when the switch is mounted in the chassis. Both switches are mounted on a bracket which stands 2 1/8in from the front panel. This will normally be supplied with the metal work kit. Flexible couplings are used to connect the two switch shafts to the front controls.

The upper switch connects to the protruding shaft of the 2 meg. fine speed control pot., and the lower switch feeds through a bush in the front panel. The bush we have used was taken from a discarded wire wound pot.

The three large capacitors on the bottom of the case are the two 1.0 mfd. low frequency boost units and the 0.27 mfd. screen bypass for the second vertical amplifier valve. The 0.27 mfd. just above

(Continued on Page 89)



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Here's your answer, Tom!

Over the next few months in these columns we will be presenting articles on the basic principles and use of electronic measuring instruments. As an introduction to this series, this month we are attempting to explain the basic concepts of electric current, magnetic and electric fields, and associated phenomena.

BEFORE we worry about any of these things, let's start at the beginning of things—with matter and its composition. "Matter," as you probably know, is another name for anything that has a concrete existence. Into this category comes everything we meet in the physical world; solids, liquids and gases.

All matter is composed of tiny units called "atoms." An atom is the smallest part of a chemical element which still has the characteristics of that element. If we set out to divide a lump of, say, iron into more and more parts, the parts naturally become smaller in size as their numbers become larger.

SINGLE ATOMS

If it were possible to carry the process far enough, we would eventually have a large number of lumps consisting of only one atom apiece.

These atoms will still be tiny bits of the original iron; they are in fact atoms of iron.

If we try to divide the atoms up into smaller pieces, however, a queer thing happens. The "bits" we obtain no longer have the qualities of iron. There may be certain quantities of particular kinds of bits, but the nature of these bits gives no indication as to the substance from which we started.

So it makes no differences as to the type of substance which we attempt to sub-divide—iron, copper, water, gas or rock. We get back to the constituent atoms and, beyond that, to the same basic "bits," of which all atoms are composed.

You may say: "Well, that's all right, but it means that the bits which comprise an atom of a particular substance are the same bits that comprise an atom of another substance. Then why is copper different from iron?"

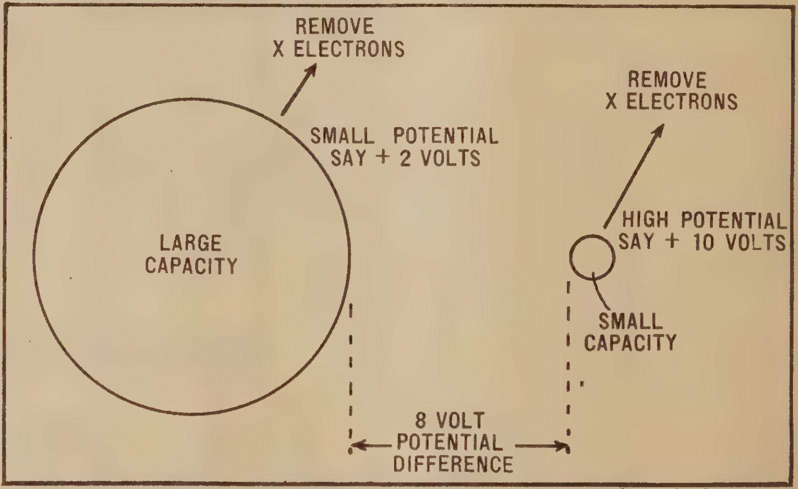
QUANTITIES

The answer here is in the quantities of these "fundamental particles" as they are called. Each atom of iron has a fixed "recipe" — so many of one type of particle, so many of another type of particle, and so on.

Each different chemical element has its own recipe. The ingredients available are the same in all cases; it's just that the quantities differ. The fundamental ingredients or particles are too many in number to be dealt with here even briefly (in fact, more and more seem to be discovered all the time) but it happens that one particular particle is responsible for most of the electrical phenomena, with which we are concerned at present. This particle is the "electron," of which you've no doubt heard. At the moment, the atom is envisaged as a sort of tiny solar system, with electrons as "planets" whizzing around a central "sun" or nucleus, which is composed of other basic particles.

Now for the electrons to continue to spin around the nucleus, there must be some force binding them to it, otherwise they would fly off at a tangent.

For planets in the solar system, we call the force gravity, but there is evidence that a different force acts between electrons and the nucleus. This force is called "electrostatic attraction" and, although we do not know what it is, we do know quite a deal about its behaviour.


REMOVE X ELECTRONS
SMALL POTENTIAL SAY + 2 VOLTS
LARGE CAPACITY
REMOVE X ELECTRONS
HIGH POTENTIAL SAY + 10 VOLTS
SMALL CAPACITY
8 VOLT POTENTIAL DIFFERENCE

This diagram shows the effect of removing the same number of electrons from two different size spheres. The larger sphere has a larger capacity, and hence is only raised to a fraction of the potential of the smaller sphere.

Electrostatic attraction is understood to exist between objects when they are oppositely "charged." The word charged is used to signify that these particular objects are somehow different from other objects which are not attracted to one another. If they are strongly attracted to one another, they are said to be "strongly charged."

To introduce a further and probably more familiar term, the quality of "being charged" is related to the amount of electric energy given to the object.

But since things can be charged oppositely, this implies that two sorts of energy can be given to objects. These two sorts of energy are called "positive" and "negative," and so things become positively or negatively charged.

Quite arbitrarily, the electron has been nominated as the unit of negative charge, while the main charged particle in the atomic nucleus, the "proton," is the unit of positive charge. Since these two particles are oppositely charged, they are attracted to one another.

It is important to note, however, that a particular piece of "space" which contains equal members of electrons and protons is not positively charged and not negatively charged but is said to be neutral.

All normal atoms of stable chemical substances have the same number of protons in the nucleus as there are electrons whizzing around it, so all such atoms are neutral. It's not that the atoms contain no electric charges; it's just that the negative charges exactly balance out the positive charges, as far as things outside the atom are concerned.

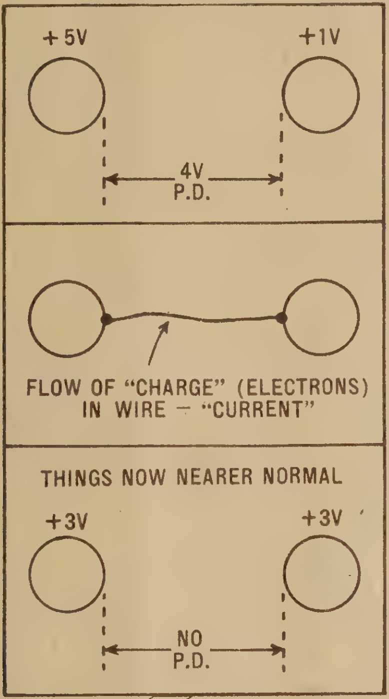
BIG EFFECT

The charges of the electrons and protons have a big effect inside the atom, however. They hold it together!

Thus normal lumps of any substance are composed of countless millions of neutral atoms. If something is done to a lump to remove a few electrons from it, however, a number of its atoms will be missing one of their complement of electrons, and will be positively charged. Thus the whole lump becomes no longer neutral, but positively charged.

Atoms which have lost one (or more) electrons and which are therefore positively charged are called positive "ions." As you can imagine, both "loose" electrons and positive ions are rather unnatural because, in the normal scheme of things, all atoms would have their correct number of electrons and the overall effect is neutral.

When electrons are removed from one piece of matter and added to another piece of matter, the balance of nature is upset. The piece which has lost electrons becomes positively charged, and the piece which has gained electrons becomes negatively charged.



A wire allows a current to flow in order to remove a potential difference and equalise charge per unit area.

Perhaps it is not surprising that oppositely charged objects are attracted to one another; it is "nature's way" of trying to restore everything to neutral.

It is reason enough, too, why two negatively (or for that matter, two positively) charged objects are repelled by one another; it is nature's way of trying to prevent things becoming more unbalanced.

You probably remember the "song" of schoolday physics — "Like poles repel, unlike poles attract." This refers to magnetism but the principle is the same. (It seems to be a sort of universal happening; think of Lenz' Law.)

FIELD CONCEPT

Now when two charged particles or objects are attracted to one another (but not in physical contact) they are said to have an "electric field" between them. This field is imagined as a sort of condition of the space between them. Since the field is thought of as a condition of the space and not of the objects, a third charged object introduced into the field can be influenced by it.

Thus an electron which finds itself in such a field will also find itself being attracted to the positively charged object, as it is acted upon by the field. Similarly a positive ion would be attracted in the opposite direction to the negatively charged object.

However, we also know that an electron placed near a positively charged single object will be attracted to it, so it seems reasonable to assume that a SINGLE charged object has a field around it. We can think of this field as an attempt to restore everything to normal.

Now the strength of the field around a charged object depends on two things —the actual amount of positive or negative charge, and the size and shape of the object. The size plays a part because of the observed fact that the charge of an object "resides" on the surface of the object. Thus if we have a small, spherical charged object and a large, spherical object with the same charge, we find that the smaller object has a more intense field around it.

CAPACITY

This can be imagined as being due to the smaller object having a bigger "charge per unit area" (because it has less area!). The bigger object has the same charge, but it is spread out over a larger area, so the effect is reduced. We say that the larger object has a bigger CAPACITY, which amounts to "effect per unit charge."

To describe the "degree of alteration" of the space around a charged object by the electric field, the idea of "potential" is introduced. This is the way potential is defined: "The potential of any point in an electric field is the work needed to bring a unit positive charge to the point from infinity." The stronger the field, the more work needed, so the higher the potential of the point. Incidentally, "infinity" is meant here as somewhere away from the field, in "normal" space.

The "unit positive charge" is merely a decided-upon amount of positive charge concentrated in a lump; it couldn't exist, but is used to help the definition.

It means that we have a definite numerical link between charge and potential, because we can say — "a point is at unit positive potential when one unit of work has to be done to bring a unit positive charge to the point from infinity."

UNITS

Unit positive charge is called the coulomb, and unit potential is called the volt.

You may quickly ask — "But what if the point is at unit negative potential? You wouldn't need to do any work, because the unit charge would be attracted to the point." That is true. In fact, you would need to do "negative work," in other words, absorb energy instead of expending it.

If two points in space, or two objects for that matter, are at different potentials, there is said to be a "potential difference" (P.D.) between them.

If one is at 2 volts positive and the other is at 10 volts positive, they are said to have an 8-volt potential difference. They can still have a potential difference of 8 volts, however, if one is at plus 4 volts and the other is at minus 4 volts. It is the RELATIVE VOLTAGE that matters.

Two objects at a potential difference will be attracted to one another as before and there will be the usual electric field between them. If we hold the two objects so that they cannot move, each will retain its charge and we have a state of enforced "non-normalcy." The

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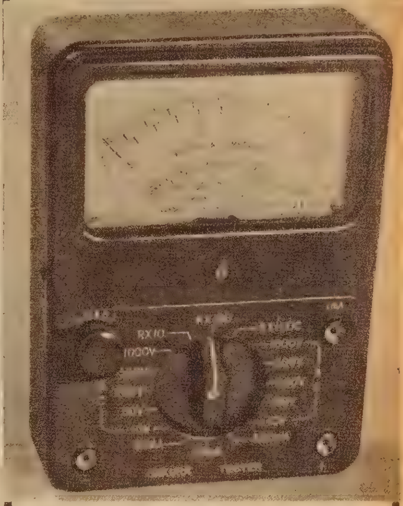

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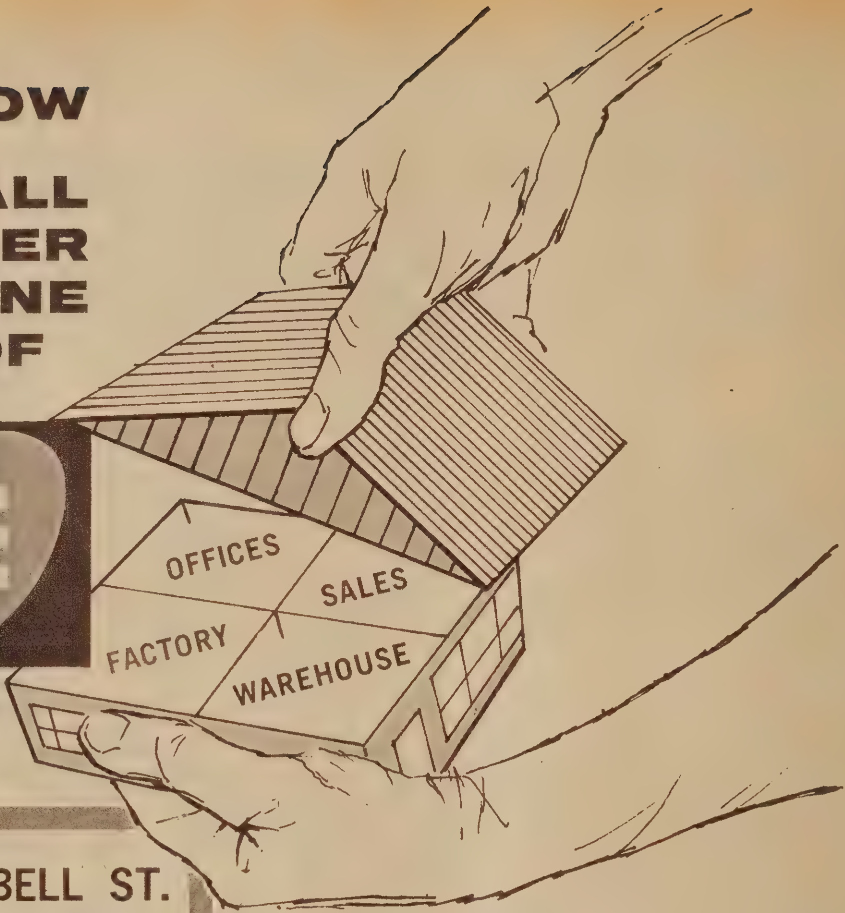

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objects cannot move together to exchange charge and bring things nearer neutral.

In fact, the charge between two bodies may be equalised, without physical contact by the process of conduction.

To understand conduction, we must return to the idea of atoms as the building blocks of matter. In lumps of any substance, the atoms of which it is composed are arranged in types of 3-dimensional patterns, "bonded" together according to the nature of the substance.

CONDUCTORS

In certain substances, the outer orbiting electrons are rather loosely held in the field of the nucleus, and are relatively easily lost. Such substances are called CONDUCTORS, as opposed to INSULATORS, in which the outer electrons are more tightly bound. In between are substances with relatively tight binding, called "poor conductors."

As you possibly know, at normal temperatures, there is quite a lot of activity in substances at an atomic level, with thermal (heat) energy causing electrons to be more active than at very low temperatures.

Some of the loosely held electrons in conducting materials become so energetic that they break loose from individual atoms and wander around. They are soon captured by some neighbouring atom, but their "wandering" is in effect movement of charge (remember that electrons are tiny negative charges). There are therefore tiny movements of charge going on continuously in conducting materials at normal temperatures.

Since the electrons literally "wander," with no fixed direction, there is thus no net movement of charge in any particular direction, and the overall effect is zero.

The wandering of electrons in a substance at normal temperature is known as "random thermal currents," as "charge in motion" constitutes what is known as "current." A current of one AMPERE is said to be flowing past a point in space if one coulomb of charge passes the point every second.

In a conductor, where the electrons are loosely bound to their nuclei, random currents are large (relatively). But, since they all cancel out, there is still no net current. Thus if we have a wire (a long length of conductor) or a circuit (a continuous path of conductors) with no external energy source applied, no current flows.

CHARGED OBJECTS

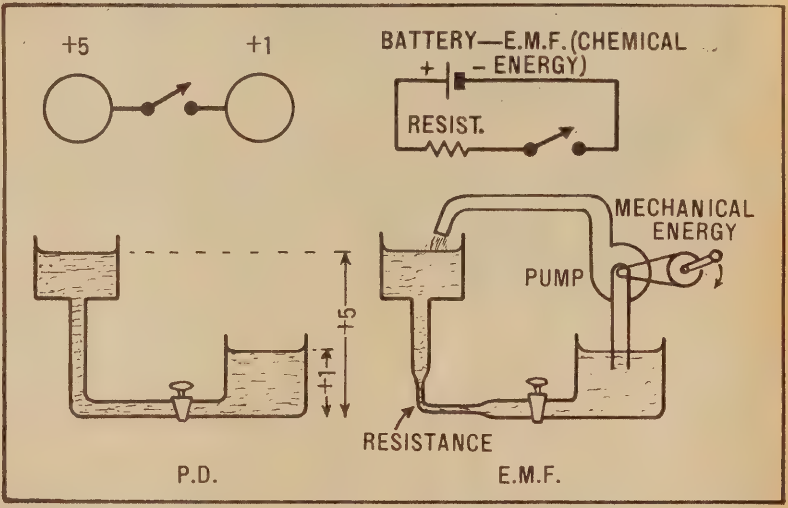
Now we can return to our two charged objects held apart in space. If we connect a length of conductor (e.g., a wire) between them, the motion of the wandering electrons in the wire suddenly becomes more pronounced in the direction towards the more positive object.

Thus we have a net effect of a current flowing—electrons are leaving the end of the wire attached to the more positive object, and helping to cancel its positive charge, while other electrons are entering the wire at the end attached to the other object, and helping to reduce its (relative) negative charge.

Thus, because at any instant there are as many electrons leaving one end of the wire as there are entering it at the other, the wire always has its correct number of electrons. But due to the current flowing, the difference in potential of the two objects is reduced, and the charge per unit area is equalised. When this finally happens, the current stops because there is no P.D. to neutralise and all action (except the previously mentioned thermal agitation and currents) ceases.

If the two objects are the same size and shape (i.e., the same capacity) they reach the same potential if they are charged by identical amounts. Thus if say "x" electrons were originally taken from one object and added to the other, the first object would have become "X" volts positive, and the second "X" volts negative. When we joined the two by a wire, however, x electrons travel back from the second object to the first, and both would finally be at zero potential and uncharged.

If, however, we had two identical objects and removed x electrons from one and 2x electrons from the other, one would be X volts positive, and the other 2X volts positive. Then when we joined them by a wire, only ½x electrons would travel the wire, and both objects would finish up at 1½X volts positive. So we can see that the current flows only to cancel the P.D. between the objects, and not to alter the absolute potential of the two object-wire circuit.



This diagram shows the difference between a Potential Difference and an Electromotive Force, using the water flow analogy.

If the connecting wire is a poor conductor, it is said to have a RESISTANCE (. . . to current), and the discharging process takes a longer time to complete. If the wire is a good conductor (has a low resistance), however, the process takes a much shorter time.

FINALLY ENDS

However long it takes, the current finally ends (for all practical purposes) because the P.D. drops to zero. There are devices, however, which can maintain a P.D. even when a current (due to the P.D.) is flowing. To do this, a device must be a source of energy, or at least a device which produces electric energy from some other form. Thus we have a battery, which converts chemical energy into electrical energy, and a generator, which converts mechanical energy into electrical energy.

We can understand the reason why such a device must supply energy if we go back to first principles. We found that currents flow when "nature" tries to restore the natural balance (by uncharging atoms and thus reducing P.D.s). If a device has to maintain a P.D. when a current is flowing to reduce it, it is in effect working against "nature" (by keeping things unbalanced), and, to do this it needs energy.

Such devices, which can be thought of as "P.D.s with energy behind them," are very common in electronics. They are called Electromotive Forces (E.M.F.s for short). Circuits which use E.M.F.s thus have currents which flow continuously, or, at least, for as long as the P.D. is operative.

An easy way of visualising batteries and other E.M.F.s, as opposed to P.D.s, is to use the good old water analogy.

We can liken a P.D. to a difference in water level in two containers joined by a pipe with a tap. If we open the tap, water will flow from the higher level (higher potential) until the water is the same level (no potential difference) in both containers. When this happens, the water stops flowing (just as the current does) and everything stops.

RESISTANCE ANALOGY

If the pipe is small in cross-section, the process takes longer than it would if the pipe was larger, so we can compare good conductors to wide pipes and bad conductors to thin pipes. Thus we can say that a thin pipe has a "high resistance"

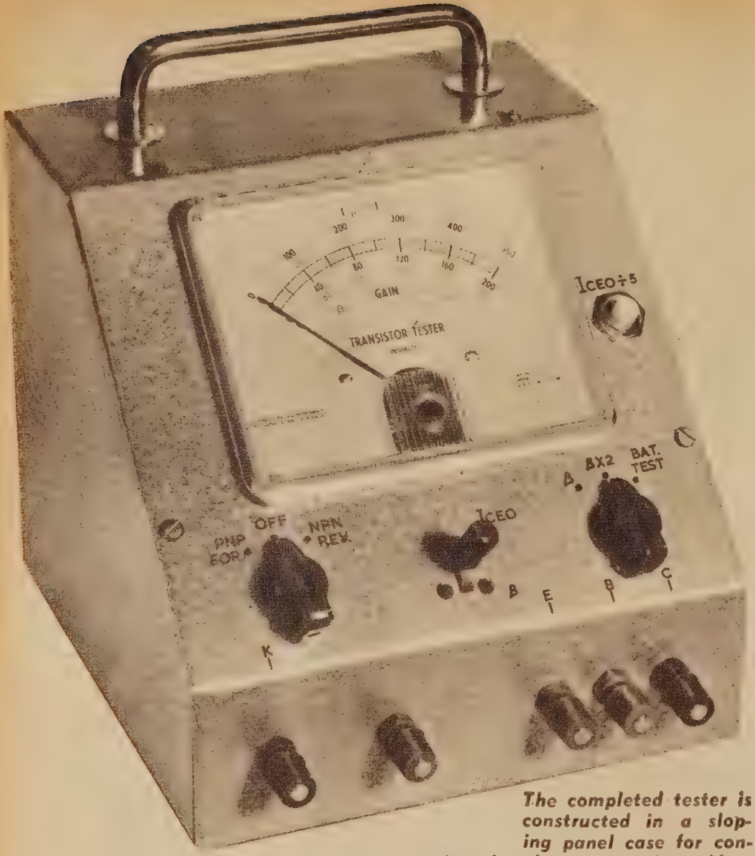
We can imagine an E.M.F. as a pump in the water case, which pumps water continuously to keep up the water "potential difference." The pump needs mechanical energy to operate, so the comparison is quite accurate. There is one point, however—the pump could pump too fast, and INCREASE the P.D.! This does not happen in an E.M.F., so perhaps we could add a special governor to the pump to make the analogy a little more accurate!

This is about all we have space to discuss this month, Tom, so we will continue next month. We still have to deal with magnetic and other effects of currents before we can start on even simple measuring instruments.

A Simple Transistor Tester

With transistor radios and other equipment becoming more and more prevalent, some type of transistor tester is necessary for efficient design, experimental or service work. This article describes common methods of transistor testing and presents a simple test instrument, suitable for small and medium power transistors.

by Jamieson Rowe



The completed tester is constructed in a sloping panel case for convenient bench-top operation. Note the "Iceo divide by 5" button to the right of the meter and the "Leakage-Gain" key switch in the lower centre of the panel.

TRANSISTORS are being used widely in modern electronic equipment, particularly in portable applications where their single-battery operation and low heat dissipation allow very efficient circuitry to be followed. Thus we find transistorised radios, test instruments, public address systems and hearing aids, along with a multitude of other transistorised devices.

LESS TOLERANT

Transistors are efficient, economical and convenient in operation, but they are also rather critical of circuit conditions, and somewhat less tolerant of overload than valves. Switching surges, abnormal values or temperature variations can easily result in permanent damage to transistors in circuit.

Thus a transistor tester becomes necessary when one is dealing with any quantity of transistor equipment.

There are many things one can test in a transistor and many ways one can test them.

There are thus several types of tester available, all quite useful over a certain range of transistors and applications. We find relatively inexpensive leakage and gain testers, as well as more costly hybrid parameter plotters and testers capable of determining almost every transistor parameter.

For experimenters and servicemen a relatively simple type of instrument is required which, like ordinary service valve testers, will indicate whether a particular unit is basically "good" or "bad." Being simple, it may not be able to indicate more obscure characteristics—or faults!

Having decided that a simple tester of this type would have quite a large appeal among readers, the remaining questions to be answered concerned the actual tests to be made on the transistor. Perhaps the best way to commence a discussion of transistor testing would be to explain the various common tests used, after which we can decide which tests are most desirable.

PNP ONLY

We shall confine our discussion to PNP transistors, since they are the types most commonly met. However, the same principles apply to NPN types, except that battery and diode polarities must be reversed.

A PNP transistor (junction type) is basically two diodes connected back-to-back, with coupling through their common electrode, the base region. In normal use the base-emitter diode is biased in the forward direction, and is thus a low resistance. The collector-base junction is biased in the reverse direction, so that it is a high resistance.

The device amplifies by virtue of the fact that a small change in current through the base-emitter junction causes a large change in the current through the collector-base junction. The transistor in this sense may thus be compared with a valve, with the exception that it is the input current which controls output current, not the input voltage as in the valve, and that the transistor is a low impedance device.

The first test normally carried out on a transistor is the measurement of one or more of its "leakage currents." Before we discuss the measurement of these currents, let us examine the nature and cause of the currents themselves.

MINORITY CARRIERS

When the base-emitter current is zero in such a transistor, collector-base and collector-emitter currents flow. These currents are usually quite small and are called leakage or saturation currents. They are due to thermal motion of so-called "minority carriers" across the junctions, and are proportional to temperature.

Incidentally, minority carriers can be free electrons in P-type germanium (or silicon) or holes in N-type germanium (or silicon).

The collector-base leakage current is known as Icbo (or Ico), meaning collector-to-base current with the emitter current zero. The collector-emitter leakage current is known as Iceo (or Ico'), meaning the collector-to-emitter current with the base current zero.

Since the two leakage currents are connected by the current gain of the transistor, it is not usually necessary to test both in a tester, particularly if one is also testing current gain. However, this does apply for power transistors, since the gain at these tiny levels of collector current is not always known (as gain varies with collector current).

For testing small and medium power transistors, however, it is quite in order to test only one of these leakage currents. Glancing at Fig. 1, we can see the two leakage measurement circuits used for PNP transistors. Since transistors are mainly found in common-emitter circuits, the most useful one to measure is usually Iceo, shown in (a).

BASIC PRINCIPLES OF TESTER

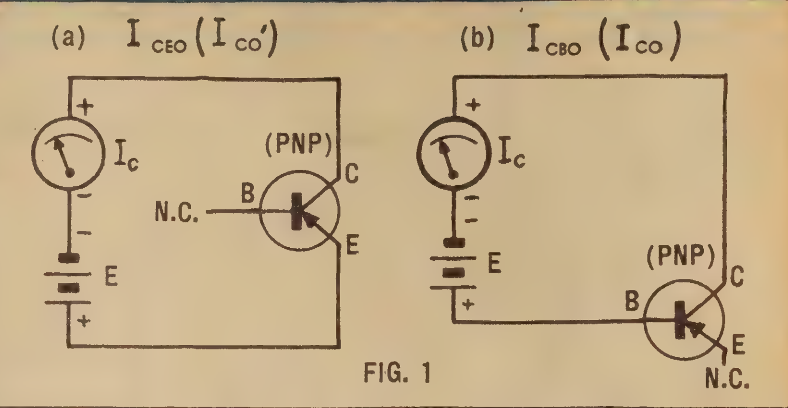


FIG. 1

Figure 1: This diagram illustrates the two main leakage currents and the circuits used in their measurement. The circuit shown for Iceo is used in the complete tester.

TEMPERATURE

Since leakage current depends on temperature, a temperature calibrated variable shunt is sometimes fitted to the meter measuring Iceo or Icbo. However, for normal experimental and service testing, sufficiently accurate readings can be obtained with a fixed shunt at normal ambient temperatures. This simplifies the construction and operation of the tester.

As we mentioned before, the transistor can amplify currents. Thus, a very good test for a transistor is to measure its current amplification factor. However, there are two different amplification factors, according to the manner in which we connect the transistor into the circuit.

If we connect the transistor in "common base" configuration, we can measure the common-base current amplification factor, Alpha. This is defined as the ratio of the change in collector current to a change in emitter current (with constant output voltage). It is always slightly less than one because emitter current is the sum of base and collector currents.

On the other hand, if we connect the transistor in "common emitter" configuration, we can measure the common-emitter current amplification factor, Beta (also known as Alpha-dash). This is defined as the ratio of the change in collector current to a given change in base current (with constant output voltage).

BASIC CIRCUITS

In Fig. 2, we can see the two basic amplification factor measuring circuits. Alpha (2b) is measured by noting the ratio of collector current change to emitter current change (when the base current is altered with R). Beta (2a) is measured in a similar circuit, but is the ratio of collector current change to base current change (base current is again altered with R).

It is fairly obvious that Alpha and Beta are only different ways of measuring the same thing. We are merely notting different effects when the transistor is used in the two basic configurations. Thus, in a transistor tester designed for general purpose testing, we can measure either Alpha or Beta to equally good advantage.

The choice of amplification tests boils down to a matter of convenience. In practice, common-emitter circuits are most common, so it is usually preferable to measure Beta. In any case, we can obtain Alpha using the fact that Beta is equal to Alpha divided by one minus Alpha.

Beta is defined as the ratio of an increment (small change) in collector current to a given increment in base current, and is thus the instantaneous slope of the Ic-Ib transfer characteristic. For really accurate measurement of Beta we should, therefore, use very small signal amplitudes, adjacent to the transistor's normal or published working point.

However, the transfer characteristic is found to be reasonably linear, so that we can use quite large signal inputs without becoming too inaccurate in our measurement of Beta. Thus, a common way of measuring Beta is to increase the base current from zero to a certain value, and note the change in collector current.

(Note: Due to the curvature of the transistor characteristics, this will result in readings which are slightly lower, in theory, than the true Beta. In practice, however, the error proves quite small, and is practically insignificant due to the "spread" of transistor characteristics.)

The collector current will rise from the leakage current Iceo to a certain value Ic, so that Beta is the ratio of (Ic minus Iceo) to the current in the base, Ib. If Ib is of such a size as to shift the transistor to a normal working point, the change in collector current will be very nearly equal to Ic, as Iceo will be small in comparison.

CONVENIENT

For this method of Beta measurement it is convenient to use a fixed value of base current, so that the meter reading Ic can be calibrated directly in values of Beta. This simplifies operation of the tester.

It is reasonably easy to provide a fixed base current step, as the base-emitter junction is forward biased and is thus a low resistance. By putting a relatively high resistance in the base lead, the base current supply becomes practically a constant current source, independent of base-emitter junction resistance variations.

We therefore have a base current which is virtually constant for all transistors, and does not have to be metered. We should note here, however, that this

$$\beta = \alpha' = \frac{\Delta I_C}{\Delta I_B} \qquad \left(\beta = \frac{\alpha}{1-\alpha}\right) \qquad \alpha = \frac{\Delta I_C}{\Delta I_E} \ (<1)$$

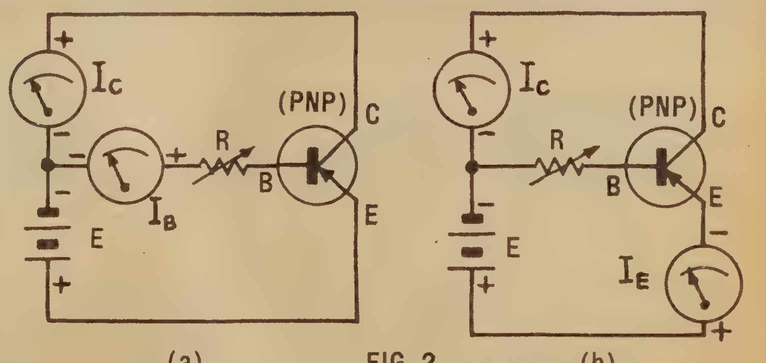


FIG. 2

Figure 2: Here are the circuits used to measure the two amplification factors of a PNP transistor. The connection between the two factors is also shown.

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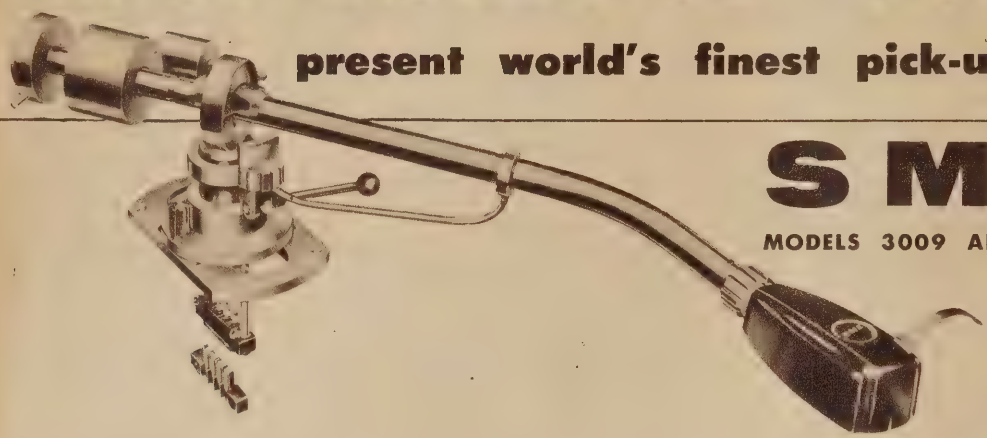

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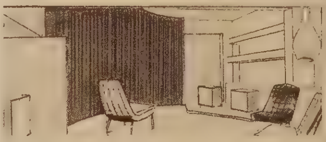

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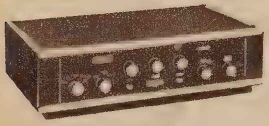

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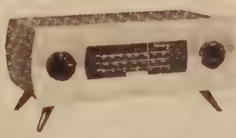

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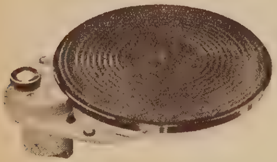

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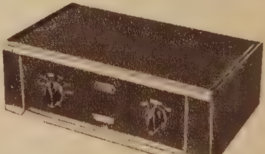

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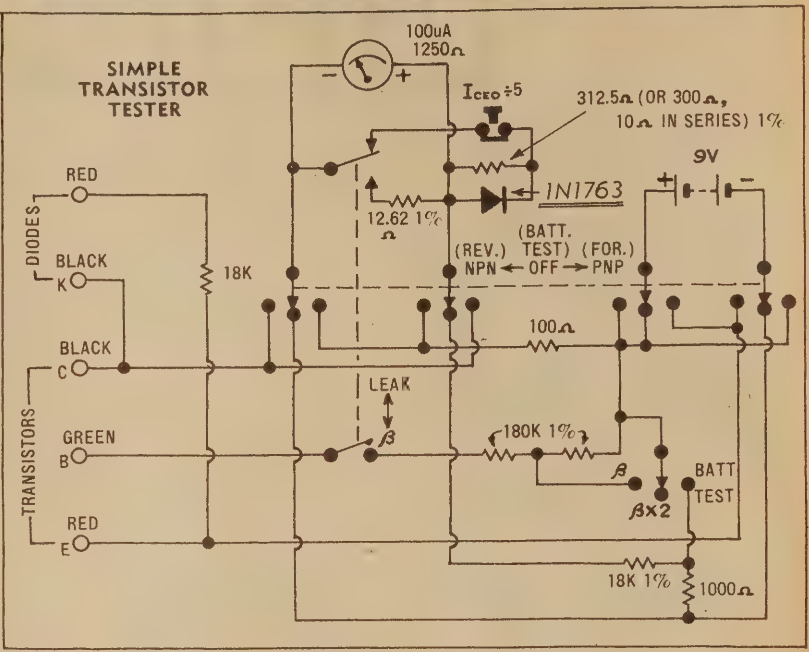
SIMPLE CIRCUIT IS VERSATILE



The final circuit of the tester is simple yet versatile. The addition of a semiconductor diode forward-reverse test to the basic transistor test circuit increases the usefulness considerably.

method is not possible for power transistors, as low input resistance and high base currents are encountered.

Fig. 3 shows a simple tester which measures Beta by this method as well as measuring Iceo. With the switch in the open position, the meter measures Iceo, while it measures Beta when the switch is closed (since Ic is proportional to Beta for a fixed value of Ib).

There are other parameters which we can measure in transistors, such as turnover voltage, Vt. Since the collector-base junction is biased in the reverse direction normally, it behaves in a similar fashion to a regular semiconductor diode which is under reverse bias.

In common with regular diodes, it has a Zener point, or reverse breakdown voltage, when it ceases to become a high resistance and behaves as a very low resistance. This naturally sets a limit upon the circuit voltages allowable for the transistor, since amplification action ceases if the unit reaches the Zener point. It thus is very handy to be able to know the Zener voltage, or turnover voltage, of a transistor.

CONSIDERATIONS

However, since small and low power transistors are usually operated well below their normal turnover voltage, the measurement of the turnover voltage becomes of secondary importance. For power transistors and special applications, however, it is frequently desirable.

Since we are dealing with low and medium power transistors for the present, we decided that the measurement of Vt could be left out without seriously affecting the usefulness of the tester. This is particularly so, since Vt would be of importance mainly in design applications rather than servicing and hobby applications.

The tester which we present on these pages is thus basically the circuit of Fig. 3, with various practical modifications made in the interests of versatility and ease of operation. We have also incorporated a forward-reverse test for semi-conductor diodes, which adds to the uses of the instrument.

The final circuit is built around a 100 microamp meter movement. A telephone type key switch is used to switch the circuit from leakage measurement to gain measurement. The switch is arranged so that it cannot latch in the gain position, but springs back to the leakage position when released.

The switch is arranged so that the meter range is automatically changed for the gain measurement. This protects the meter from accidental overload. Incidentally, the contacts of the switch should be bent so that the range is changed before base current flows—but we will discuss this a little later.

$$\beta = \frac{I_C - I_{CEO}}{I_B} \approx \frac{I_C}{I_B}$$

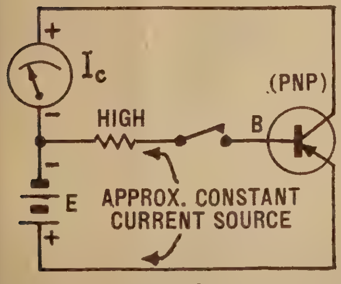


FIG. 3

Figure 3: This simple circuit allows both Iceo and Beta to be measured.

The main function switch is a 4-pole 3-position rotary type. It is used as an NPN-OFF-PNP switch, two of the poles reversing the battery while the other two reverse the meter polarity. Thus both PNP and NPN types of transistor can be tested.

NORMALLY SHUNTED

In the leakage function, the meter is normally shunted so that it reads 500 microamps full scale. This range is quite suitable for many of the common transistors, but even at present there are a few types whose Iceo would be rather hard to read on this scale. We have therefore provided a push-button labelled "Iceo divide by 5" which removes the shunt, allowing low leakage currents to be read on a 0-100 microamp scale.

Incidentally, this sensitive scale allows Icbo to be measured quite easily on the tester. To do this, merely connect the transistor collector and base leads to the collector and EMITTER terminals of the tester. The reading then obtained will be Icbo, read on the same scales used normally for Iceo. However, remember to reconnect the transistor in the correct fashion before attempting to measure Beta.

In the gain measurement function, a base current is applied to the transistor and the meter records the Beta of the transistor by measuring the change in collector current. The meter is shunted in this position by a 12.62 ohm shunt, which results in a full-scale sensitivity of 10 milliamps.

Thus if a 50 microamp base current is applied to the transistor the meter can be calibrated with a range of 0-200 for Beta. This range is suitable for a great many common transistors but, again, we find that some of the newer types (notably of the drift variety) have gains which may be too large for this scale.

It is for this reason that we have incorporated a switch into the base series circuit. When this switch is turned to the "Beta times two" position, the series resistance in the base circuit is doubled, so that the base current is effectively halved to 25 microamps.

This means that the meter now reads Beta on a 0-400 scale, so that the range of the tester is doubled.

You will notice that this switch has a third position, labelled "battery test." When the "NPN-OFF-PNP" switch is in the off position, this position connects the battery to a dummy load and the meter is connected by a suitable multiplier resistor to check the battery voltage. The multiplier is an 18K high stability type, and gives the meter a full scale sensitivity of 9 volts. A red line was marked on the scale of the meter coresponding to 8.1 volts, and the battery should be replaced when the reading is less than this figure.

METER PROTECTION

The INI763 diode across the 500 microamp shunt protects the meter from damage due to serious overload, which might otherwise occur if a short-circuited transistor were inserted into the tester. Since the 500 microamp is the first meter range applied to the transistor, it is the only range on which overload protection is normally needed. A transistor which reads "hard over" full scale on this range is either damaged or a high power type, and thus cannot be tested further on this tester.

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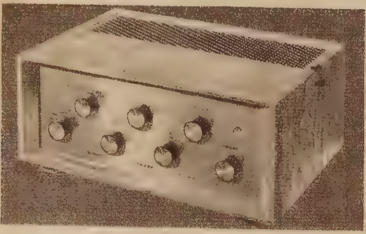

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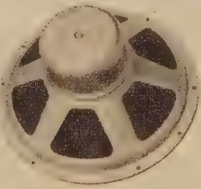

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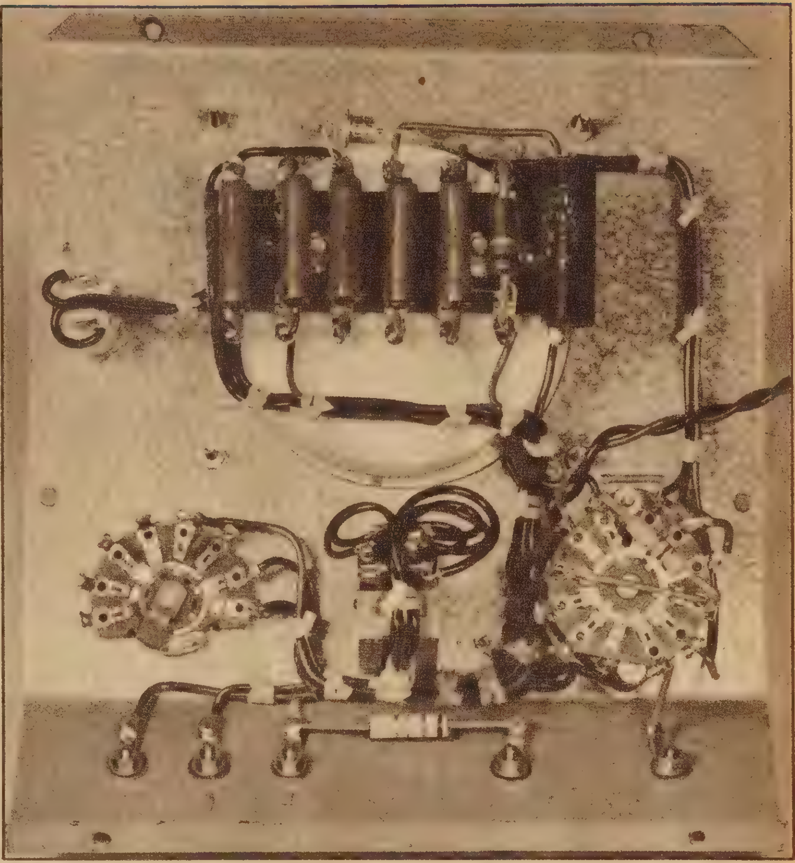

This view of the rear of the panel clearly shows all the components with the exception of the battery. This is clamped firmly inside the case with a bracket bent from sheet aluminium. A plug and twisted lead connect it to the rest of the circuit.

The method of meter protection used here relies on the slope of the forward resistance characteristic of the diode. This method was described in some detail in the December, 1959, and January, 1960, issues of the magazine, in connection with the "Bench Style Multimeter." Briefly, it uses the fact that the diode exhibits a high forward resistance at very low forward voltages, but a very low forward resistance at higher voltages.

Since, in the event of a short-circuited transistor, the INI763 would be placed directly across the battery, it too must be protected from damage due to overload. This is the job of the 100 ohm series resistor in the collector supply line, as it limits the current to a safe value. The resistor protects the INI763 and the INI763 protects the meter.

The diode test terminals are wired in parallel with the collector and emitter terminals, but have an 18K series resistor in one lead. This means that the meter is effectively a series ohmmeter, and when the NPN-PNP switch is operated it reads reverse and forward diode resistance. No scale is provided for this function since the "front-to-back" resistance ratio is usually the only information required.

WILL VARY

In any case, it should be realised that the actual readings will vary by a small amount over the life of the battery. Thus unless a calibrating variable resistance were included, an actual resistance scale would be subject to error.

To ensure stability and maximum accuracy, the resistors in the base circuit, battery test multiplier and meter shunt positions should be 1 per cent tolerance, high-stability types. Incidentally, the meter shunts can be easily obtained from meter manufacturers. The remaining resistors in the tester can be of normal type.

Now for some mechanical points about the tester. The original seen in the photographs was constructed in a sloping panel instrument case similar to that used for the "Bench Style Multimeter." The two rotary switches and the key switch, together with the meter and its "leakage divide by five" button were mounted on the sloping panel. The diode and transistor test terminals were arranged below the panel on the front face of the case.

We have been in contact with case manufacturers, and at least one manufacturer is preparing cases with engraved panels made to our drawings, so there should be no difficulty in obtaining ready-made cases. Similarly, at least one meter manufacturer will be able to supply meters with appropriate scales (made to our specifications) by the time this issue is published.

The "collector" and "cathode" terminals are black, the "emitter" and "anode" terminals are red, and the "base" terminal is green. Note that a transistor collector pigtail is usually marked by a dot, while diodes usually have the cathode marked with a dot or white band.

A seven-lug length of terminal board is bolted to the rear of the meter using the meter terminals themselves. This board supports most of the minor components of the tester, with the exception of the 100 ohm protective resistor and the 18K diode series resistor. These are wired directly to the switch and the test terminals.

The contact springs of the "leakage-gain" key switch should be bent slightly to make sure that the contact connecting the 10mA shunt contacts slightly before the base current contact. This will ensure that the meter is not temporarily overloaded for an instant when the key is pressed. If the switch is purchased from disposals sources you should also make sure that the contacts are clean.

TWO SOURCES

Regarding this switch, there appear to be suitable units available new from regular component suppliers. However, there are also quite a few ex-P.M.G. units available from disposals sources. These are quite appreciably cheaper than the new types and, with careful cleaning, perform equally well. (As the photographs show, a disposals type was used in the original tester.)

There is not a great deal more that need be said about the construction of the tester, since the wiring is simple and the fact that it operates under DC conditions makes it non-critical. As can be

PARTS LIST

1	**Sloping Panel Instrument Case, approx. 7in x 7in x 7in.**
1	**100 microamp 4 inch rect. meter 1250 ohms internal resistance with special scale.**
1	**4 pole 3 position rotary switch.**
1	**P.M.G. type key switch (two pole, changeover, sprung).**
1	**Single pole 3 position rotary switch.**
1	**Press-off push button.**
1	**9 volt battery.**

RESISTORS

2	**180K 1% high stab.**
1	**18K 1% high stab.**
1	**312.5 ohm 1% high stab. (or 300 ohm and 10 ohm in series).**
1	**12.62 ohm 1% high stab.**
1	**100 ohm ½ watt carbon.**
1	**1000 ohm ½ watt carbon.**
1	**18,000 ½ watt carbon.**

SUNDRIES

2 red, 2 black, 1 green terminals. Battery plug, 7 lug length of Terminal board, Rubber feet and handle for case.

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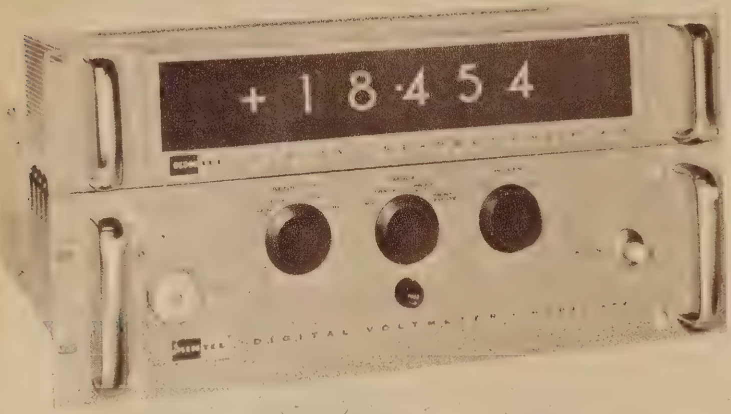

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EXAMPLES OF TRANSISTOR DATA

OC45

Germanium Transistor

P-N-P Intermediate Frequency Transistor

Description

The OC45 is an intermediate frequency germanium junction transistor of the P-N-P alloy type, in all-glass construction.

Applications

The OC45 is specially suited for intermediate frequency use, as 455 kc/s amplifier and in high speed switching circuits.

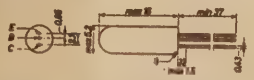

Fig. 1. Dimensions in mm and electrode connections of the OC45.

Thermal Data

Junction temperature rise to ambient temperature, transistor in free air between 0 °C and 75 °C	K	≤	0.6	°C/mW
Storage temperature	T_s	=	−55 to +75	°C
Junction temperature (continuous operation)	T_j	= max.	75	°C
Junction temperature* (intermittent operation)	T_j	= max.	90	°C¹)

Absolute Maximum Ratings

Collector
Voltage (base reference)
Peak .... $-V_{CBM}$ = max. 15 V
Average .... $-V_{CB}$ = max. 15 V

Typical Characteristics at an ambient temperature of 25 °C

		min.	av.	max.	
Common base					
Collector current at $-V_{CB}$ = 2 V; I_E = 0	$-I_{CBO}$ =		0.5	2.0	μA
$-V_{CB}$ = 15 V; I_E = 0	$-I_{CBO}$ =			10	μA
Emitter current at $-V_{EB}$ = 2 V; I_C = 0	$-I_{EBO}$ =		0.4	2.0	μA
$-V_{EB}$ = 12 V; I_C = 0	$-I_{EBO}$ =			40	μA
Current amplification frequency cut-off at $-V_{CB}$ = 6 V; I_E = 1 mA	f_α =	3	6	12	Mc/s
Common emitter					
Collector current at $-V_{CE}$ = 2 V; I_B = 0	$-I_{CEO}$ =		12	40	μA
Current amplification factor, output short-circuited at $-V_{CE}$ = 6 V; I_E = 1 mA; f = 1000 c/s	α_{FE} =	25	50	125	
Base input voltage at $-V_{CE}$ = 6 V; I_E = 1 mA	$-V_{BE}$ =	145	170	195	mV

NOTE

β

The above data sheet, reproduced from the Philips data book shows one method of presenting the data discussed in this article. Note particularly the spread of values for Beta. Below is portion of a data sheet from AWV showing essentially similar information, but presented in a different form.

een from the photograph. it is quite asy to make a neat job.

Now we must consider the main oints about using the tester. Before transistor is connected into the circuit, he main switch should be in the "off" osition. The "Beta-Battery test" switch hould then be turned to the battery est position, when the meter will read he battery voltage under load.

If the needle does not swing past the Battery Test" mark, the battery is exausted and will affect the accuracy. It hould be replaced. Presuming the batery is in good condition, the transistor connected to the terminals.

The "Beta-Battery test" switch is rerned to the "Beta" position, and the ain switch turned to the right or the ft, according to whether the transistor a PNP or NPN type.

OUR READINGS

The meter will now read the collectornitter leakage Iceo, on the 0-500 icroamp scale. Four types of reading ay be encountered here: no reading, ceptable reading, very low reading, d "hard over" reading.

The last reading indicates either a orted transistor, which should be disrded, or a high power type, which nnot be satisfactorily tested further on is instrument.

Of the other three types of reading, e "acceptable reading" is the easiest— e transistor may then be tested for rrent gain.

The "no reading" or "very low reading" units may be observed more accurately by pressing the "Divide Iceo by 5" button. On this more sensitive scale the "low reading" type may turn out to be merely a low leakage type, which is usually acceptable. The "no reading" may also prove to be unusually low but more usually, an open circuited transistor, which may be discarded.

If there is a definite leakage current, no matter how low, do not discard the transistor, but pass on to the gain test and use this as the final "judgment."

The gain or Beta test is accomplished by depressing the key switch and holding the switch down. The meter now reads Beta on a 0-200 scale. If the meter needle goes full scale, turn the Beta switch to the centre "Beta times 2" position, which should enable the gain to be read.

On either scale, a reading which is abnormally low for the type of transistor being tested indicates that the unit is partially defective and should be discarded. A reading which is practically equal to or above that expected for the transistor under test indicates that the unit is satisfactory and suitable for most applications.

SHORTCOMING

As occasionally found in valve testing, a unit may test satisfactory in the tester yet refuse to operate in a certain circuit; oscillator circuits are typical offenders. The more comprehensive the tester, the less the likelihood of this happening. However, a simple tester such as the one described will prove quite satisfactory for a majority of transistors and applications.

If a transistor is poor, the wisdom of using it in a circuit is questionable, even though it may seem to operate satisfactorily.

As mentioned before, semiconductor diodes are tested by connecting the diode to the appropriate terminals and turning the main switch to the PNP and NPN positions. The meter will give readings in these positions which are proportional to forward and reverse resistance of the diode.

SHORTED DIODE

A diode which reads full scale in both positions is no longer a diode but a short circuit! Similarly a diode which has no reading in either position is no longer a diode but an open circuit. Other than these two extremes, the quality of a diode is judged by the front-to-back ratio. Thus the better the diode, the higher its forward reading and the lower its reverse reading (in terms of current).

Putting it in other words, a perfect diode would act as a short circuit in the forward direction and an open circuit in the reverse direction.

Finally, for your reference, we are printing a short list of popular types of transistors, with the leakage and gain

2N219

GENERAL DATA

Electrical:

Collector:

DC voltage (Minimum value) for dc collector current of −10 microamperes with emitter open, and at an ambient temperature of 25°C.	−16	volts
DC current (Maximum value) for dc collector voltage of −12 volts with emitter open, at an ambient temperature of 25°C	−6	μa

This is I_{CBO}

Emitter:

DC current (Maximum value) for dc emitter voltage of −12 volts with collector open, and an ambient temperature of 25°C	−40	μa

NOT I_{CEO}

(REALLY I_{EBO})

Mechanical:

Outline and Base C

Mounting Position .... Any

CONVERTER SERVICE

Maximum Ratings, Absolute Values:

COLLECTOR:		
DC voltage	−16	volts
DC current	−15	ma
Dissipation	35	mw
EMITTER:		
DC voltage	−12	volts
DC current	15	ma
AMBIENT TEMPERATURE:		
Operating	+70	°C
Storage .... −55°C to	+85	°C

COMMON-EMITTER CIRCUIT

Characteristics at Ambient Temperature of 25° C.:

Average Collector Characteristics	See Fig. 1	
DC Collector-to-Emitter Voltage	−9.0	volts
DC Emitter Current	0.6	ma
Current Transfer Ratio (Measured at 1 Kc)	−48	

β

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8K	£2 12 6	8M	£3 14 0
8MX	£4 10 6	9-6H	£3 0 6
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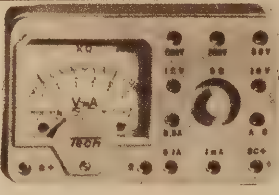

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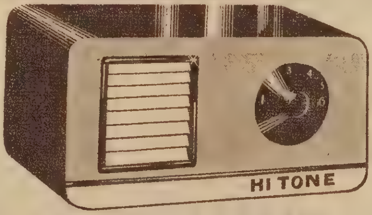
0 — 50V	0 — 50V	0 — 100MA
0 — 250V	0 — 250V	0 — 500MA
0 — 500V	0 — 500V	
0 — 1000V	0 — 1000V	

OHMS RANGE—0-100,000 OHMS.



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- 1 .001/600 Capacitor.
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TEST FIGURES

TYPE	Iceo (uA)	BETA
TS1	30-50	15-20
TS2	50-80	40
TS3	70-130	70
OC44	10-25	50-220
OC45	10-30	30-130
OC70	95-225	20-40
OC71	100-320	30-75
OC72	60-300	50-150
2N185	70	35-60
2N217	100-200	70
2N218	20	40
2N219	20-60	50
2N370, 2N371	80-200	60-200
2N372	100-200	60-200
2N373, 2N374	20-100	60-200
2N406	70	35
2N408	150	65
2N412	150	75

igures which can be expected from each ype. Due to the spread encountered n transistor characteristics, the figures hould be used as an approximate guide nly.

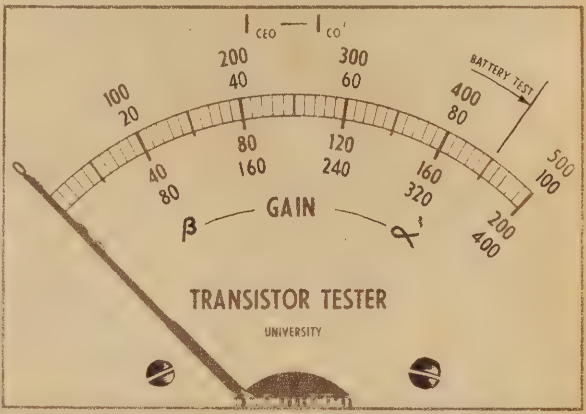
Incidentally, a good idea of the spread f transistors may be obtained by testng all brand-new units before use. In his manner one may also calibrate the ester for transistors whose official charcteristics are not known, such as tranistors in foreign equipment.

NOT LISTED

Data on transistor types not listed ere can usually be obtained from the anufacturers' data books, or direct om the manufacturer on request. ortions of typical data sheets are reroduced on page 71, showing how this ata normally is presented.

You will notice that both sheets give leakage figures for a definite temperature. As mentioned before, leakage currents are due to random motions of minority carriers across the junctions, and are thus very dependent on temperature. (One authority states that Iceo doubles itself for every eight degrees centigrade rise in temperature.)

The table at left gives test figures for types of transistors in current use. At right is the meter scale on which these will be read. The leakage figures are above the arc and the gain figures below it.



This fact should be noted particularly in connection with the measurement of Iceo on this tester. One can very easily be tricked into throwing away a transistor for high leakage if by some means the temperature of the transistor has been raised.

Thus a transistor which has been held in the hand for a few minutes prior to testing may read quite appreciably higher than normal. Due to the thermal lag of the grease inside some transistors, this effect may show up as a reading which slowly rises to a certain value, and then slowly falls again to its normal reading as the temperature falls to the ambient level.

All this goes to show that one should not be too hasty in declaring a transistor ruined! On one of these scorching Australian days any transistor can appear to be doubtful.

However, taking all this into consideration, you will find that this tester will be of considerable help on the service bench or in the home workshop. While only a simple tester, it can answer most of the "Is it the transistor?" questions.

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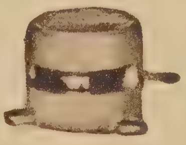

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Note: "T" denotes upper half track, "L" lower half track, all others full track (except H4 and EH4, which are half track).

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1 7/8 ips STEREO TAPE SYSTEM

Mention was made last month in an "Off The Record" column of a new tape recording and playback system which has been developed by the CBS Laboratories in conjunction with 3M. The following is a precis of a paper on the subject from the magazine "Audio."

A prototype of Columbia's 1⅞ ips tape system mounted in a typical cabinet. The operator is holding one of the tape cartridges.

In order that recorded tape can take an important place in the field of home entertainment, one must take into account many requirements, some of which are not easily met. For instance:

1. **The tape must be contained in a compact cartridge in a way that no part of the tape is exposed.**
2. **The amount of tape must be small and the cost of the cartridge low in order that the price can approach that of the disc record.**
3. **The sound should be stereophonic with provision for three tracks for maximum flexibility.**
4. **A complete musical composition should be played without interruptions; that is without reversing the cartridge or tape.**
5. **The quality of sound should be at least as good as the best of existing recorded media.**
6. **The durability of the tape and cartridge must be high enough so that after several hundred plays, the sound remains unchanged.**
7. **It should be possible to place a number of cartridges on a tape machine equipped with a changer-type mechanism so that one can provide music for several hours.**

It was clear from the outset that one was dealing with a system rather than just a few components. Thus intensive development work over a period of several years progressed simultaneously in such areas as methods of signal recording, magnetic transducers and playback heads, design of cartridges and tape transport mechanisms.

NEW TAPE

The laboratories' system work, in close co-operation with 3M, also included the development of a new tape with characteristics that provided optimum matching into the overall performance.

Late last fall the new recorded system was in a sufficiently advanced stage to demonstrate it to members of the industry.

3M had, at that time, stated that the Zenith Radio Corporation had joined the effort and entered the design of commercial equipment based on these developments.

Some of the important features and parameters of the new tape cartridge system are as follows:

1. **Tape speed is 1⅞ ips. The width of the tape is 150 mils; the thickness 1 mil, and there is provision for three tracks. Each track is 40 mils wide.**
2. **The cartridge is approximately 3¼in square and 5/16in thick. The cartridge contains sufficient tape to play continuously for 64 minutes, and will carry more than 98 per cent of compositions available without interruptions. The space occupied by the cartridge in its container is approximately 4 cu in.**
3. **The tape machine can take five cartridges and play them automatically one after the other. A cartridge can be rejected during any part of its play. The production versions of this machine now under development by Zenith will have fast forward and reverse speeds. The same instruments will also serve as a home recorder using cartridges with blank tape.**

THIRD CHANNEL

Earlier reference was made to a third track which is located in the centre of the 150-mil tape.

Extended studies have been undertaken to determine the optimum acoustic conditions desired by the listener in the average home while playing recorded music.

Conventional stereophonic music provides only a portion of the sounds that are perceived by the listener sitting in a concert hall. A large percentage of the total acoustic energy which reaches the listener's ears is reverberated and delayed sound which is considerably depleted of its original stereophonic character.

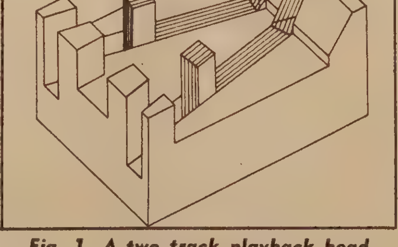


Fig. 1. A two track playback head assembly, of the type used in this equipment.

Experiments have shown that in space simulating the average living room a much more realistic sound ca be produced, giving an illusion of "being there." Thus, it is intended to recor on the third track as an optional featur on the new recorded tape system th stereophonic sum signal delayed and reverberated to an optimum degree.

The reproducing instruments can b manufactured for two or for three tracks

The data and curves shown are already based on the newly developed tap and represent the overall behaviour o the entire system, that is, recording, tape and playback.

The new tape is now in pilot production at 3M, but the cartridges played i current demonstrations still use the olde tape.

A comparison of the new tape system with the original 15-ips tape master, from which both the stereo records as well a the new tape cartridges have been derived, has been demonstrated with success.

DIRECT COMPARISON

For this purpose, some sections o music were alternately transcribed from the original master and the 1⅞-ips narrow track version on to a 15-ips half-track tape.

In order to achieve an adequate signal-to-noise ratio, frequency response, and dynamic range at a tape speed of 1⅞ ips significant development of most components used in magnetic recording are required. For instance, due to the shorte wavelengths encountered, developments have been aimed at reducing wavelength-dependent losses.

Among the losses in reproductio which have been minimised in the system are those attending (1) separatio of head and tape surface, (2) azimuth alignment of head and tape, and (3) playback-head efficiency. Losses miniised in the recording process are (1) pe-thickness loss, (2) recording-field nfiguration loss, and (3) loss caused by on uniformity of tape particles.

(A) Losses In Reproduction.

(1) There is an exponential reduction of the playback-head flux with decreasing recorded wavelength due to the finite separation between the surface of the tape and the playback head pole pieces. At 15,000 cps and 1⅞ ips, this loss is almost 0.5 db per micro-inch separation.

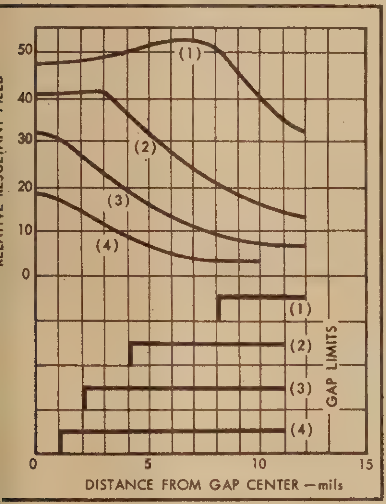
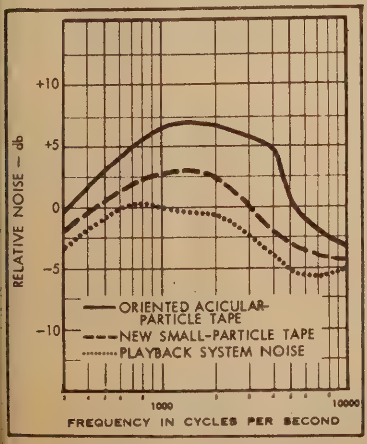


Fig. 2. In recording equipment, the length of the recording gap can be significant. This graph shows the rate of field extinction as a function of gap length.

(2) Another important loss is associated with the azimuth alignment between the playback-head gap and the line of constant recorded magnetisation across the track width. For a conventional 90-mil track a loss of 6 db occurs at 15,000 cps and 1⅞ ips, for a misalignment angle of 3 minutes.

(3) The proportion of playback-head flux shunted by the gap will increase when using the narrow gaps necessary to resolve the shortest wavelengths recorded at a tape speed of 1⅞ ips. In order to maintain a high efficiency it is necessary to compensate for a reduction in gap length by a corresponding reduction in gap depth.



ig. 3. Zero modulation noise urves with correct playback equalsation plus the 40 phon ear characteristic.

(B) Losses in Recording.

(1) A separation loss of the type described for reproduction occurs during recording due to the finite coating thickness. These particles remote from the tape surface will thereby give an attenuated contribution to the tape-surface flux and so will contribute less to the playback-head flux.

(2) The magnetisation of a recorded tape will not be uniform throughout the coating thickness since it depends on the rate of extinction and the direction of the recording field when the critical value for recording is reached after the tape has passed the recording gap. In addition to this, a further loss can occur due to change in phase of the recorded signal through the coating thickness caused by the vertical curvature of the effective recording plane of the recording-head field.

RECORDING PROBLEMS

(3) For high resolution of the effective recording plane a sharp cut-off of the recording field must be accompanied by a high uniformity in the magnetisation characteristics of the individual particles of the tape. Elimination of particles with low critical fields for switching will also reduce self-demagnetisation effects. The separation loss has one advantage in slow speed tapes for audio, since, due to the shorter wavelengths involved, print through is correspondingly reduced allowing new thin tape backing materials to be used with safety.

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Fig. 4. Maximum output curves showing the improvement resulting from the use of newly developed tapes.

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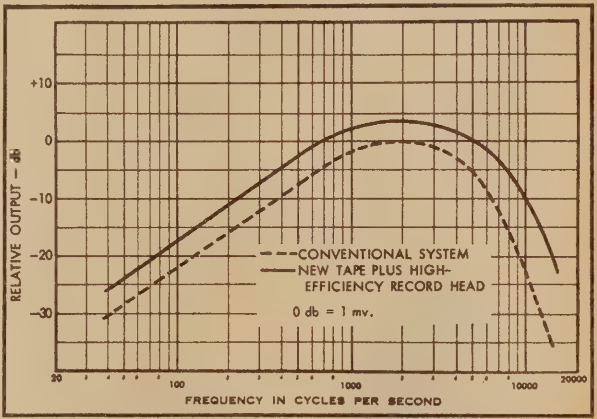

Although the major loss component, called separation loss, is inherent in presently known magnetic recording systems, it has been possible by improvements of tape and heads to achieve performance characteristics approaching those presently obtained from 7.5 ips machines. Such performance is achieved with a track width of 40 mils. Having a narrow track reduces the alignment problem.

It has been found that a conventional laminated ring-type playback head can be constructed to be responsive up to 15,000 cps with a 1.5 mv output from a tape having 1/3 mil. coating thickness. A sub-assembly of the two-track version of such a head is shown in Fig. 1. The playback-head coils fit over the projecting laminations.

Since the recorded wavelength at 15,000 cps is only 1/8 mil, it is necessary to form an effective magnetic gap of 1/16 mil (or 1.5 microns). It has been found that a 1-micron spacer gives satisfactory head resolution in prolonged use. By manufacturing the multitrack head in two halves, automatic colinearity of the gaps is assured, and in practice the 10,000-cps sensitivity of the tracks differ by less than 4 db.

Similar mechanical refinement is necessary in the recording head. Fig. 2 shows a plot of the field distributions at 0.1 mil spacing for various gaps. It is seen that the field decrement increases somewhat with gaps which are large compared to the spacing.

RECORDING-FIELD FACTORS

Thus a long gap might be thought advantageous, especially since the vertical field decrement is also reduced. In practice, however, the expected improvement does not occur, probably due to the relatively greater vertical component of the effective recording field. Considerable development has been carried out to improve the recording-field configuration for the very short wavelengths involved in this system.

Significant advances have been made by 3M in the recording media, leading to considerable reduction of the separation loss effects. Firstly, a tape lacquer has been developed which is relatively soft, giving good head-to-tape contact. Particle rub-off on guides and heads has virtually been eliminated and the consequent amplitude variations considerably reduced at the shortest wavelengths.

In addition, the laboratories developed a higher-output and lower-noise tape as a result of changes in the magnetic material itself. Previous work has concluded that a reduction of effective particle size results in lower tape noise. The improvement achieved is shown in Fig. 3, where the weighted noise response for existing tape is compared with the new tape using optimum bias for each. A 4-db lower noise level is obtained in the mid-frequency range.

HIGH FREQUENCY

Higher over-all output is also obtained from the new material.

It is found that the short-wavelength efficiency is particularly improved. One reason for this is that a deliberate attempt was made to reduce the speed of critical fields required for magnetisation change in the individual particles.

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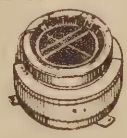

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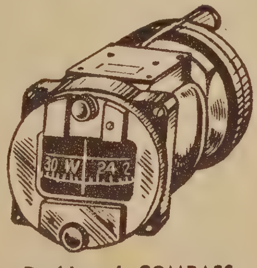

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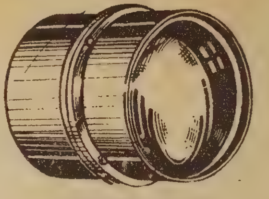

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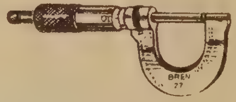

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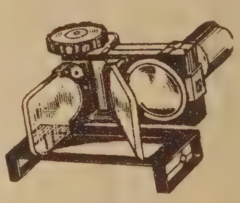

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Figure 4 shows the improvement resulting from recording with the new tape using one of the high-efficiency recording heads compared to that obtained with conventional 1 7-8-ips recording.

The recording equalisation adopted for the new 1 7-8-ips record-replay system is shown in Fig. 5. This curve was derived by performing many listening tests on a variety of program material. It is the characteristic which meets the requirement to load the tape optimally at all frequencies without overload danger.

Using this in conjunction with the playback equalisation (also shown in Fig. 5) a flat response is obtained from 30 to 15,000 cps at –18 db relative to a level giving 3 per cent distortion at 1000 cps. Under these conditions the ratio of the maximum signal level at 1000 cps to the zero-modulation system noise is 54 db.

APPROACHES 7½ IPS FIGURES

The 10,000-cps signal response at this maximum signal level is —12 db relative to that at low frequencies.

Typical equivalent signal-to-noise ratio for professional 7½ ips half-track systems is 54 db with a corresponding 10,000-cps signal response at —6 db. Thus the new system with its own recording and play-back characteristics approaches the 7.5 ips performance available today and has been found to be entirely adequate for all types of musical programs.

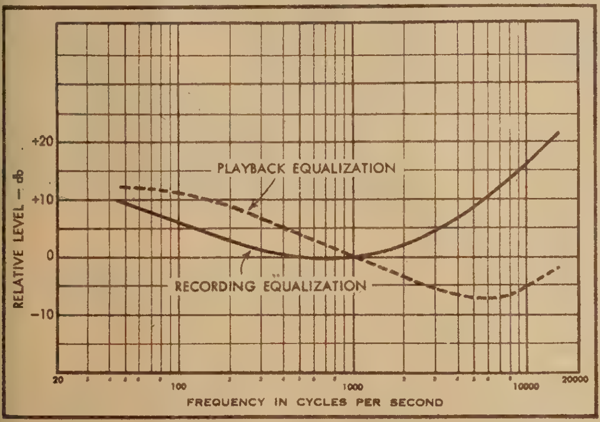

Fig. 5. Recording and playback equalisation curves used in the new system.

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One of the central problems in recorded tape systems is the design of the tape packaging. Obviously, it is necessary to satisfy requirements of convenience as well as to provide adequate protection for the tape.

In order to popularise tape it is essential to eliminate the process of manual threading between the reels. This requirement is dictated by the need for avoiding manual threading and also by the requirement to make the cartridge compatible with a practical automatic changer mechanism.

On first examination the notion of hreading tape permanently between two ide-by-side reels contained on the cartridge is attractive. However, every practical design incorporating both the upply and take-up reels in the cartidge requires that sections of the tape be exposed through openings in the cartridge walls with consequent dangers of damage.

Even in a single cartridge player there are many difficulties involved in coupling the tape of a dual-reel cartridge to the drive system and the heads, but when the design of an automated changer is considered, these problems increase rapidly in number and magnitude.

A basic consideration in any type of cartridge is the need for relatively high speed transport in so-called "search" operations. If flanges are used on the reels inside the cartridge, the bulk is considerably increased and many problems of stability are encountered.

WINDING PROBLEM

Thus, high-speed winding without flanges requires some method of maintaining a separation between the tape and the cartridge walls.

The three dimensional geometry of the reeled tape, the driving spindle in the transport mechanism, the walls of the cartridge and other components call for strictly orthogonal relationships of some automatic dynamic adjustment and an accurate system of tape guidance. Otherwise the cumulative errors in repetitive reeling of the tape, even on the same machine, will lead to telescoping or angular displacement of the tape reel with respect to the cartridge walls.

In brief laboratory experiments those problems may not be evident but in long-term field use the increasing friction produces instabilities in the tape speed and eventually may completely block the reel from rotating.

The problem of smooth reeling without any flanges was solved by introducing a novel guiding member in the cartridge with adequate compliance to insure a smooth rewind cycle. This arrangement allows a tape with an hour of playing time to be rewound in twenty seconds. (A five-second rewind time has been achieved in the laboratory.

FERMANENT LEADER

Threading of the tape is accomplished by means of a leader permanently attached to the takeup reel in the mechanism. The end of the rewind cycle leaves the permanent leader in the threading path of the machine.

A very simple and economic solution was used for the design of the coupling between the reeled tape and the permanent leader. This consists of a "U" shaped device attached to the end of the tape in the cartridge and so shaped that it seals off the only opening in the cartridge when the tape is fully rewound.

The permanent leader terminates in a dumbbell-shaped element that readily mates with the "U" shaped clip. The dumbbell attached to the permanent leader can slip through the "U"-shaped clip in a vertical direction with only a light detenting restraint but provides an absolute coupling in terms of horizontal pull when the two members are engaged. (Fig. 6)

In order to eliminate variations in back tension with dynamic changes in effective reel diameter, a felt pad is spring-loaded against the surface of the tape as it leaves the cartridge and the supply reel is operated in free-running bearings. This provides excellent tensioning characteristics and at the same time maintains the cartridge complexity cost at a minimum.

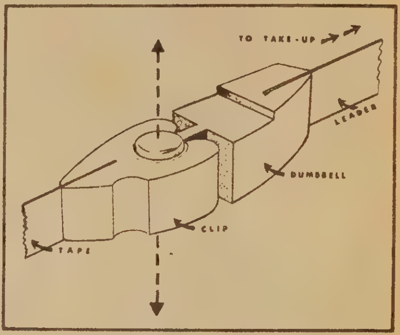


Fig. 6. Coupling members used to connect the permanent leader to the tape contained in the cartridge.

Some kind of braking mechanism is essential in order to avoid partial unreeling and fouling of the tape within the cartridge under normal conditions of handling. The brake must be positive, reliable, and simple to assemble. The device selected consists of a linkage mounted in the cartridge hub and spring-loaded in a ratcheting relationship with teeth moulded in the cartridge wall. When the cartridge is placed on the machine, the spindle releases the brake automatically. The brake is shown in Fig. 7.

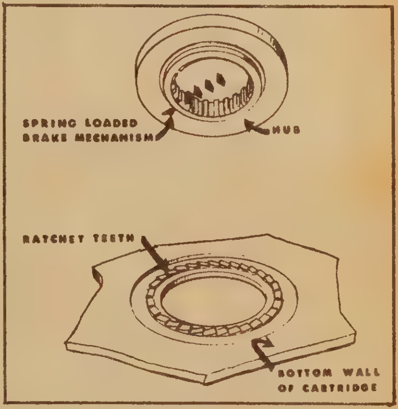


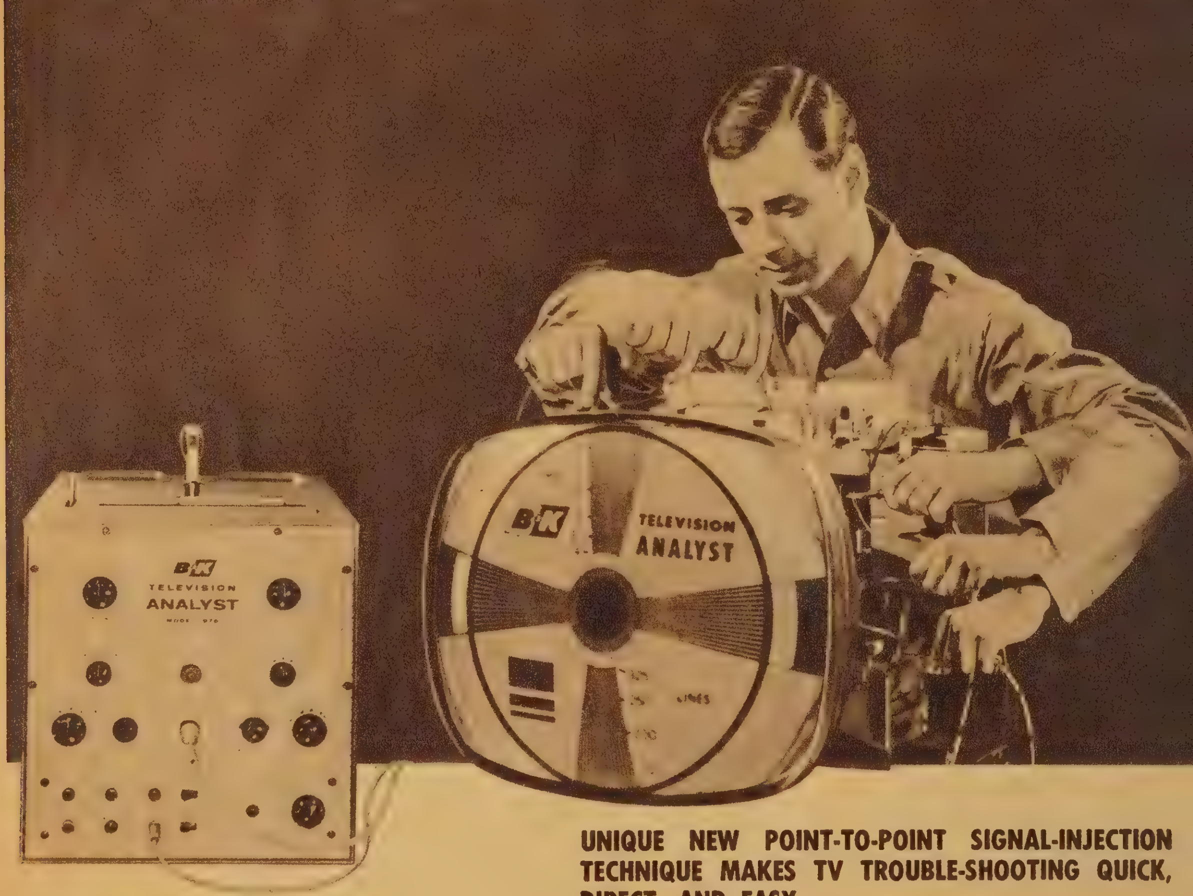
Fig. 7. The automatic brake mechanism which is released when the cartridge is placed in the machine.

The facility for driving the cartridge hub during the rewind cycle must be designed so as to permit random rotary orientations of the spindle with respect to the cartridge hub in the loading pro-

(Continued on Page 128)

Visual stage by stage testing with the

B&K TELEVISION ANALYSER



UNIQUE NEW POINT-TO-POINT SIGNAL-INJECTION TECHNIQUE MAKES TV TROUBLE-SHOOTING QUICK, DIRECT, AND EASY.

Revolutionary development by B. & K. *improves servicing techniques,* aids every service technician, makes television set servicing faster, easier, and more profitable!

Now, *by rapid sectional signal substitution,* you can drive separate sections of TV receivers. By point-to-point signal injection and test pattern reproduction, you can easily troubleshoot and signal trace *any stage throughout the video, audio, r.f., i.f., sync, and sweep sections* of black and white and colour television sets.

With the remarkable B. & K. Model 1075 TELEVISION ANALYST, you can accurately isolate any faulty stage and quickly diagnose any TV troubles (including intermittents). *No external scope is needed.* By use of the generated test pattern, you can *actually see the resultant condition directly on the picture tube of the television set itself,* and easily correct any trouble to the satisfaction of your customer, and your own profit.

TEST EACH STAGE SEPARATELY

R.F. and I.F.
Supplies complete r.f. and i.f. signals with test pattern, video and tone audio modulation.

VIDEO
Reproduces a complete test pattern on the screen of the TV set.

SYNC
Provides composite signal, sync positive or negative.

AUDIO
Provides an FM modulated 5.5 Mc/s sound channel.

For further particulars please contact Engineering Products Division

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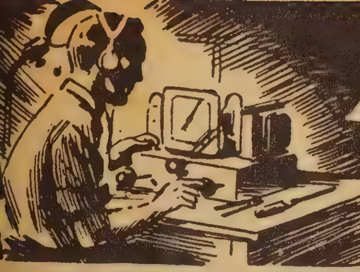
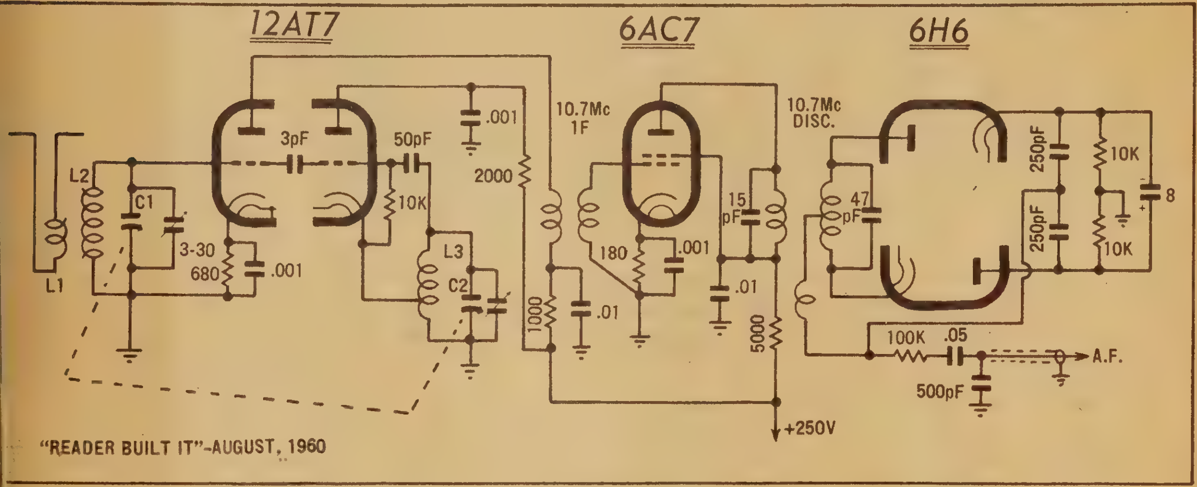


A READER BUILT IT!

Gadgets and circuits which we have not actually tried out, but published for the general interest of beginners and experimenters.

SIMPLE FM TUNER USES ONLY THREE VALVES

For many beginners who want to make a start on FM, the cost and complexity of most circuits must present a barrier. Since all that many fellows require is something that will work with reasonable efficiency in good signal strength areas, there would appear to be a need for something more in keeping with the simple sets of years gone by. Here is one attempt at the problem, contributed by Mr C. Cogzell, of 38 Bernhard Street, Paddington, Queensland. He writes as follows:


12AT7
6AC7
6H6
L1
L2
C1
3-30
680
.001
3pF
50pF
10K
.001
2000
L3
C2
10.7Mc
1F
1000
.01
180
.001
15
pF
.01
5000
10.7Mc
DISC.
47
pF
250pF
250pF
10K
10K
8
100K
.05
500pF
A.F.
+250V
"READER BUILT IT"-AUGUST, 1960

THE circuit uses a 12AT7 as an oscillator mixer, converting to 10.7 Mc. he tuning condenser was cut to size removing all but two of the moving ates from a standard miniature connser.

The IF amp is a 6AC7 which would about the best valve in this position th regard to its gain and its price. The transformer in my case is an exsposals type, but a home-made type uld be used. The discriminator transrmer is home-made and, incidentally, ound to R, TV and H specifications nuary, 1957 edition).

DEQUATE

I have thoroughly tried the unit and performance is more than adequate a dipole cut to 94.1 megacycles, ich is the frequency of the Brisbane transmitter.

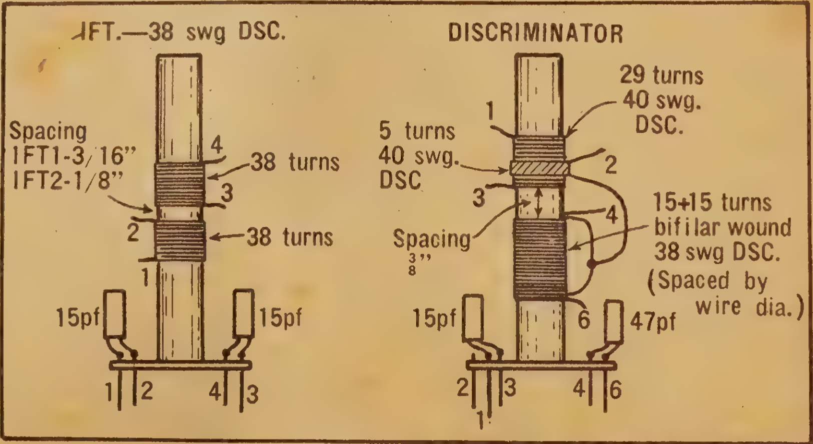
On this antenna I also receive Channel ABQ). However, with a better aerial, bile FM stations can be received also. distance from the transmitting site uld be about five miles, but the antennae are blocked from view.

Coil data is as follows:

L1. 2 turns 21 gauge tinned copper wire.

L2. 2½ turns 21 gauge ½in dia. spaced ½in.

L3. 2 turns 21 gauge ¼in dia. spaced 5/16in tapped ¾ turn from earthed end. The wire used was plastic covered 21 gauge hookup wire with the plastic covering removed. The coils are self supporting.


IFT.—38 swg DSC.
Spacing
IFT1-3/16"
IFT2-1/8"
4
38 turns
3
2
38 turns
1
15pf
15pf
1
2
4
3
DISCRIMINATOR
29 turns
40 swg.
DSC.
1
5 turns
40 swg.
DSC
2
3
4
Spacing
3/8"
15+15 turns
bifilar wound
38 swg DSC.
(Spaced by
wire dia.)
15pf
6
47pf
2
3
4
6
1

This is the coil data which Mr Cogzell used for his set. It is reproduced from our files for the benefit of other readers who may like to wind their own.

Playmaster
VOLUME
TREBLE
BASS
BALANCE
SELECTOR
STEREO
REVERSE
MONO
RADIO

Here is a front view of our Unit Amplifier No. 2. The front panel and the standard label have been retained. The case. is identical in dimensions to that of the Unit No. 1 except in depth, to which 1¼in has been added.

Unit Stereo Amplifier No. 2

Following the latest design trend in amplifiers, we have here a more powerful version of the amplifier described in our April issue. With over 7 watts of audio available in each channel, it should find a ready application in lower-cost medium-power installations.

THERE is always a steady demand for simple amplifiers of moderate quality and output, suitable for use with crystal pickups, such as are currently being offered in a wide range of types.

There was an immediate response to the single-ended amplifier, described in the April issue, as evidenced by kitset sales by our advertisers. However, it also prompted questions about an amplifier along the same lines, with a more substantial output.

The amplifier about to be described is designed to meet this demand.

SINGLE UNIT

As with our first Unit Amplifier, three important factors have made it possible to combine the control and amplifier sections into a single unit not too much bigger than the conventional Control Unit alone.

These factors are (1) the availability of miniature components; (2) the use of multipurpose valves, and (3) the use of silicon diode rectifiers. The latter make possible a reduction in both the size and the heat radiation from the power supply.

It thus becomes possible to house the entire amplifier in its own case, styled to harmonise with most furnishing schemes. Finished in a gold hammertone lacquer, it may grace your bookshelf, record-player cabinet or occupy any other convenient position in the living-room.

The metal box for the new cabinet is similar to the original, the main differences being an increase in the depth of approximately 1 inch, and a perforated metal rear panel to improve ventilation.

The space-saving advantage of this form of construction becomes more than apparent with a stereo system and the need to accommodate an extra speaker.

The choice of a suitable circuit for our new amplifier was almost automatic. Maximum use had to be made of dual type valves, and the type 6BM8 seemed a logical choice. Two such valves may be arranged in a push-pull circuit, performing four separate valve functions.

The pentode sections operating in push-pull, with plate and screen voltages of the order of 250 volts, are capable of an output approaching 8 watts. The drive requirements can be handled by the two remaining triode sections, connected as a conventional phase changer and driver respectively.

Distortion figures may be a trifle higher than from our more powerful and more expensive designs, but the combination of ultralinear operation and negative feedback will nevertheless ensure excellent results.

Total cathode current for the outpu stage is comparatively low, at 60 m/ per channel. The various triodes do no require more than a few milliamps s that, by using a 150 mA power supply a handy margin is available for a tuner

While we have concentrated on com pactness and economy, we certainly nee not apologise for the performance. Use with good output transformers (and ther are several reasonably priced units cur fently being marketed) the sound qualit is excellent and power output more tha adequate for average requirements. Fur thermore, we feel that this is about th cheapest way of obtaining 8 watts c good audio.

FEEDBACK CIRCUIT

It will certainly justify a pair of mod ern twin cone speakers, preferably 12 inch types, each mounted in, say, "Boffle" or vented enclosure.

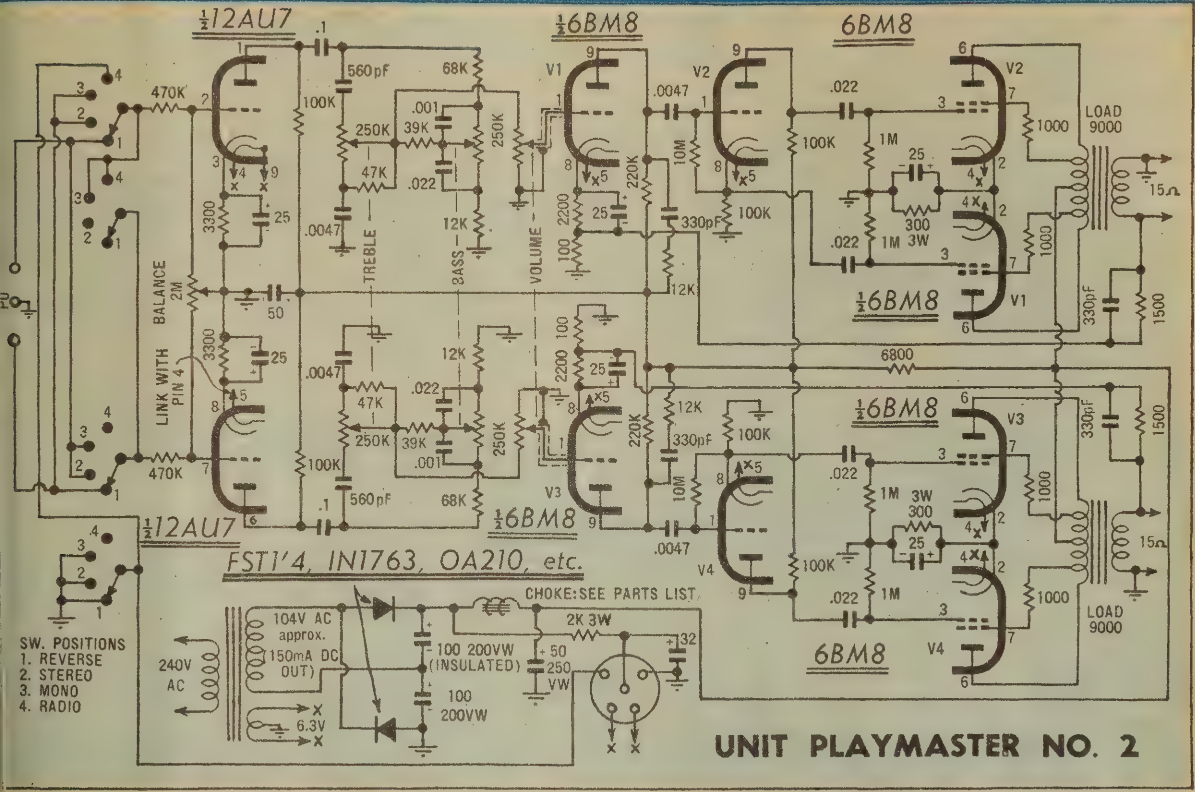
Looking at the circuit more closel you will note that we have used the we tried arrangement of feedback fror voice coil to the cathode of the drive valve. Some 13 db of feedback is pro vided, but more could be applied if th lower gain could be tolerated. Alterna tively, a little more gain could be obtain ed by increasing the 1500 ohm feedbac resistor and reducing the 330 pF bypas by about the same amount.

You will also note a step circuit in th

by

Wes Yashin

CIRCUIT USES CONVENTIONAL AUDIO SYSTEM


½12AU7
.1
560pF
68K
½6BM8
V1
6BM8
V2
470K
100K
.001
39K
250K
250K
.0047
.022
47K
12K
TREBLE
BASS
VOLUME
2200
100
220K
10M
330pF
100K
1M
25
300 3W
1000
LOAD 9000
15Ω
3300
BALANCE 2M
50
LINK WITH PIN 4
12K
6800
1500
V3
V4
½12AU7
FST1'4, IN1763, OA210, etc.
CHOKE: SEE PARTS LIST
104V AC approx.
150mA DC OUT)
240V AC
6.3V
100 200VW (INSULATED)
2K 3W
50 250 VW
32
100 200VW
SW. POSITIONS
1. REVERSE
2. STEREO
3. MONO
4. RADIO
UNIT PLAYMASTER NO. 2

The circuit is quite straightforward, being a combination of circuits used on previous occasions. The only departure from the conventional is use of silicon rectifiers in the power supply. Resistors and capacitors used in the tone control networks should be 5 per cent types and reasonably matched.

late circuit of the driver valve, which rovides a roll-off at high frequencies to vercome ringing due to phase shift and improve stability. Used in conjunction ith the phase correction capacitor cross the feedback resistor an adequate argin of stability is obtained.

Since transformer characteristics vary, is almost impossible to specify values for such correction circuits that are optimum for all transformers. Hence it is necessary to compromise and the values suggested are sufficiently broad to suit several representative transformers we have tried. For really optimum performance, as judged on instruments, individual adjustment is the only certain way.

Of the several transformers we have tried, all exhibited good square wave characteristics and no trouble should be encountered by prospective builders, using the values indicated.

As usual, the polarity of the negative feedback has to be established by trial and error. If connection of the feedback makes the amplifier squeal, then it is positive instead of negative, and it will

PARTS LIST

1 Chassis 12in x 7½in x 1¼in.
1 Case, internal dimensions 12¼in x 4½in x 7¾in deep. Rear to be of perforated metal. Top to be louvred, with a generous pattern of holes underneath. The depth of the top to exceed that of the bottom by ¼in (i.e. 8¼in total).
1 Panel, with rolled edges, to fit internal dimensions of the case.
1 Control Unit label, with 5 knobs to match.
1 Power transformer approx. 105 volts AC at 150 mA DC, 6.3 volts c.t. at 5 amps.
1 Filter choke, either 1 or 2 Henries at 150 mA or television type.
2 Output transformers, primary 9000 ohms P-P, with screen taps. Secondary to suit voice coil of speaker.
5 Noval sockets.
1 2 x 2 x 5 Oak switch.

VALVES.

4 6BM8, 1 12AU7.

RECTIFIERS

2 FST1/4, 1N1763, OA210, etc.

CAPACITORS

2 100 mfd 200 vw electrolytics, one to be insulated.
1 2 x 50 mfd, 350 vw dual electrolytic.
1 32 mfd, 350 vw pigtail type electrolytic.
2 25 mfd 25 volt electrolytics.
4 25 mfd 3 volt electrolytics.
2 .1 mfd 400 volt paper.
4 .02 mfd 400 volt paper.
2 .02 mfd 200 volt paper.
2 .0047 mfd 400 volt paper.
2 .0047 mfd 200 volt paper or styroseal.
2 .001 mfd 200 volt paper or styroseal.
2 560 pF ceramic or styroseal.
4 330 pF ceramic or styroseal.

RESISTORS

1 2000 ohm 3 watt.
2 300 ohm 3 watt.
1 6800 ohm 1 watt.
2 10 meg. ½ watt.
4 1 meg. ½ watt.
2 470K ½ watt.
2 220K ½ watt.
6 100K ½ watt.
2 68K ½ watt.
2 47K ½ watt.
4 12K ½ watt.
2 39K ½ watt.
2 3300 ohms ½ watt.
2 2200 ohms ½ watt.
4 1000 ohm ½ watt.
2 1500 ohm ½ watt.
2 100 ohm ½ watt.
1 2 meg liner potentiometer.
3 250K log dual potentiometers.

SUNDRIES.

3 Utilux type connectors, 2 4-pin speaker plugs and sockets, dial lamp holder with lamp and bezel, 1 5-pin tuner plug and socket, 2 8-lug tag strips, 2 6-lug tag strips, 1 4-lug tag strip, 2 3-lug tag strips, 6 grommets, length of 3-core flex and a 3-pin plug, tinned copper wire, spaghetti, hookup wire, solder, solder lugs, nuts and bolts.

SCOOP PURCHASE

ELECTROSTATIC SPEAKERS

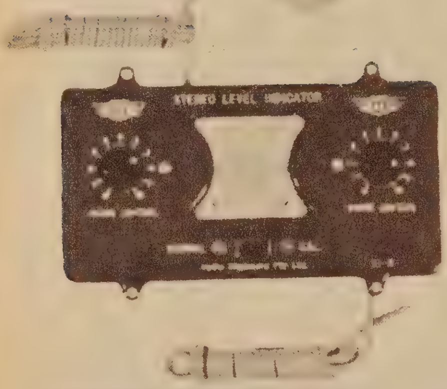
These sensational high frequency units are made by the famous Lorenz organisation of Germany.

Featuring a specially designed gold sputtered polythene diaphragm, these are eminently suitable for supplementing the frequency response of speaker systems to give clean response up to 20 Kc/s.

Simple to instal. Available in 3 models at sensational prices:

Model LSH 100,	20 watts (illustrated) ..	£1 0 0
Model LSH 518,	6 watts, wide angle ..	0 17 10
Model LSH 75,	6 watts	0 12 3

LEVEL METERS



Here is an unequalled opportunity to obtain a correctly designed v. type meter, calibrated both in decibels and 0-100 per cent.

Frequency response is plus minus 2dB from 20 cps—20 Kc, sensitivit adjustable from 23 volts down to 1.9 volts (for full scale deflection The minimum inpedance (at maximum sensitivity) is approx. 8,000 ohms These meters may be used for a variety of purposes, including frequenc response and level checks, modulation level indication, etc.

AVAILABLE IN TWO MODELS:

Mono Model, AU-B, panel mounting, one movement in attractive case **£3/9/**

Stereo models: ST-A for portable operation, or ST-B for panel mounting (a illustrated), contains two separate movements reading on a common scal with **individual sensitivity settings** and a foolproof calibration facility. Abso lutely essential for stereo balancing .. .. **£**

FANTASTIC VALUE!

G.E. STEREO CARTRIDGES

Professional type GC5 with .5 mil. diamond stylus.

Tracking force 2-4 grams. Frequency response 20-20000 cps.

£10/19/6

20 WATT POWER AMPLIFIERS . . .

Frequency response at full output—20-20 KC. Plus minus 2dB, sensitivity, 150 mV. Ideal for that second stereo channel. Brand new. Fully guaranteed

£25

TAPE RECORDERS AND ACCESSORIES

We have full stocks of tape recorders and accessories, including the famous Tandberg range; 3 models for all stereo or mono purposes, giving studio machine performance in truly portable units. Prices range from **£226 to £266.**

REMEMBER! We are stockists of all types of high fidelity and stereo equipment. Cabinets, speaker cloth, loudspeakers, transcription turntables, pickups, amplifiers, control units, record changers, diamond styli, etc. etc.

***IF YOU ARE INTERESTED** in any equipment in this field, whether listed above or not, contact us:—*

STOP PRESS!

NEW ARRIVALS

Grado Pickup arms and cartridges. Audio Empire Arms and Cartridges. S.M.E. 12in and 16in arms. Further details on request.

ARROW ELECTRONICS
PTY. LTD.

A member of the AE group of companies

422 KENT STREET, SYDNEY. **BX6731.**

ncrease the gain of the amplifier. To correct this condition, simply reverse either the primary or the secondary connections of the output transformer, not both.

Naturally enough, both channels need o be checked.

The power supply uses a pair of silicon diode rectifiers, and this contributes o a smaller power transformer in three ways. These are: A direct saving of watts previously needed to operate the heaters of a conventional rectifier; the absence of wasted wattage due to the drop across the rectifier, which is normally supplied by the transformer; the use of a full-wave voltage doubling circuit which requires only a simple single section secondary.

These factors enable a transformer to be wound on a core almost half the size previously required.

The saving in the transformer cost is, o some extent, offset by the more elaborate filter system required and extra cost of the silicon diodes. However, against this is the fact that silicon diodes should have an unlimited life.

The power transformer you will normally purchase for this amplifier will have several taps. The lowest voltage tap, approximately 104 volts, should be used. The tuner supply is taken from the first filter capacitor through its own decoupling network consisting of a 2000 ohm resistor and a 32 mfd bypass electrolytic. This arrangement allows a tuner o be connected without seriously reducing HT voltage to the amplifier.

TONE CONTROL

The tone control circuit is quite conventional by now, having been used on previous occasions. The constants in the bass and treble networks have been adjusted to give a slight increase in gain, in the same manner as was done in our Control Unit No. 10.

Even so, the gain of the 12AU7 just offsets the loss in the network, and we found it desirable to modify the input divider network. As shown in the circuit, the sensitivity is adequate for most stereo crystal pickups with just enough to spare, which is really a good thing.

A higher gain valve such as the 12AX7 appears to be unnecessary and, particularly if a high output pickup is used, could cause trouble due to its being driven into the overload region on peak passages. This stage is vulnerable to excessive input, since the volume control operates in its output—not input—circuit.

Nevertheless if, for some reason, the gain is inadequate, the 12AU7 could be replaced with one having a higher amplification factor or, at the extreme, with 12AX7. Some extra loss due to Miller effect will be evident, though it should still be within the scope of the treble control to correct.

LAYOUT OF UNIT

The layout of the unit has been arranged to enable a standard Control Unit label to be used. Matching gold-centred knobs provide a finish in keeping with the rest of the unit.

The unit was built on a chassis measuring 12in x 7½in. The ends of the chassis are bent up to form brackets, to which the front panel is attached. A section of the front of the chassis is cut away to allow for the controls and their wiring, and the rear is bent down to form the rear lip.

Details of the box and chassis have

MONTHLY NEWSLETTER

Dear Reader,

This month we would like to relate two stories, both on the same subject but with very different themes and completely different endings. The first concerns a wealthy man-about-town who visited us recently. We had never seen this man before but were obviously impressed with his arrival, complete with black limousine and cigar, and the usual sweeping manner of a man who has a lot of money to spend and intends making an impressive show spending it.

After the usual preliminaries he announced that he wanted the most expensive array of stereo equipment money could buy adding, of course, that this would give him the best stereo in Melbourne. We took this with a grain of salt, but, nevertheless, obeyed the customer's wishes and demonstrated to him practically everything he had in stock. It was evident, after a short while that he had been reading a few magazines because he knew the brand names well and, in his final choice of equipment, selected the gear with the best name.

Now the story here must be carefully noted. He certainly bought the best he could or, perhaps the correct way of putting it would be that he spent as much as he could, with the ever-repetitive theme that "it doesn't matter what it costs," and then drove away happily with the black limousine bulging at the seams. We were left with a large cheque and did not recover from the experience for days as he completely took us by surprise.

Now we will leave the first incident for the moment and start on the second which concerns a young man who, we guess from his comments on the equipment, was a P.M.G. trainee who had been saving up for a long time to equip himself with stereo. He purchased the required equipment with a lot of care and forethought, the emphasis being not on price but on quality of sound and comparative value for money. Overall, his complete system only cost him approximately £180—which to him, and to most of us, is a lot of money.

Now we put the two stories together for a moment. Within the next week or so we had phone calls from both these people asking us to call and listen to their systems, as each had some minor point he wanted to query and on which he wanted our opinion.

We separate the stories again: the first man, with his ever-present cigar, received us in state and, after stepping four feet into the living-room, thrust a decanter of whisky at us and proceeded to lay down his theories and praise up his own system before we even had a chance to hear it. We eventually got around to running some tests on it and having a good, solid listen. It sounded shocking!

This, mark you, was not the fault of the equipment he purchased which was, as we all know, the best in the world. It was caused by the manner in which it was chosen and the way the components were mis-matched with each other. It took a solid evening's work and some pretty convincing proof to persuade this gentleman to send back to us some of his equipment in exchange for other gear which was more in balance with what he had in mind. The final result sounded very attractive and we left him, I believe, a satisfied customer with a very expensive system which sounded in keeping with his taste.

The second chap's trouble was only a minor matter concerning a faulty turntable, which we duly replaced with a new one from stock and we had to admit to ourselves that the sound from that system was excellent.

Now perhaps this is a long way of going about pointing out the fact that it is not the amount of money that is spent on a system that counts although, within reason, the best equipment naturally does not earn its name for nothing. The whole point is, that it is the care and thought with which the units are chosen in balance with one another that gives the final result and not the indiscriminate purchasing of gear purely for its reputation and expensive price tags.

We have proved, time after time, that only experience can show the correct selection of equipment and it is this experince we try to pass on to you to aid the purchasing of your new system. Trusting you will give us the opportunity of being of service to you,

Yours,

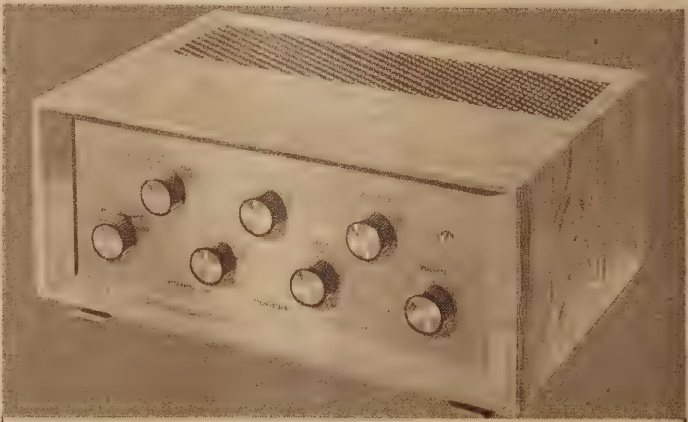
UNITED ELECTRONICS (A/SIA)
PTY. LTD.

31-33 CAMBERWELL ROAD,
CAMBERWELL JUNCTION Phone: WB 3333

2 BANK 18 WAY VOLUME SELECTOR GIVES ACCURATE STEREO BALANCE WITHIN ±.5DB!

No other amplifier has all the features of the HG 88.

- High sensitivity PICK-UP INPUTS suitable for any monaural or stereo pick-up currently available.
- High sensitivity CCIR compensated TAPE INPUTS.
- Dual inputs for RADIO, MICROPHONE and AUXILIARY.
- Four-position FUNCTION SELECTOR.
- Five-position INPUT SELECTOR.
- Wide range continuously variable ganged BASS, TREBLE and LOW-PASS FILTER controls.
- Built-in HIGH-PASS FILTER.
- Precision-ganged VOLUME CONTROL.
- Separate BALANCE CONTROL.
- Dual outputs rated at 8 WATTS per channel. Push-pull "UL" Mullard ECL 82'S.
- Output transformers with grain orientated laminations.
- Dual contact-cooled rectifiers. Mains transformer with copper screen.
- DUAL TAPE RECORDER OUTPUTS (low impedance 10K).
- Available in Figured Teak Case with Brushed Brass on Ivory Panel.



The most critical design feature of any Stereo Amplifier is the Volume Control. The Volume Control fitted to the Model HG 88 is unique in that, instead of the customary potentionmeter, a two-bank, 18-way selector, wired with 5% tolerance resistors, is employed. This form of control ensures that stable accurate stereo balance is maintained at all volume settings, within ± .5DB in this case, and avoids the difficulties associated with carbon potentionmeters when used for stereo. As far as we know this feature is exclusive to the Model HG 88. "Integrated Line."

ROGERS HG88

Australian Agent:

BRITISH MERCHANDISING PTY. LTD.

60 Clarence Street, Sydney. BX 1571

Please send me, a copy of leaflet describing the new Model HG 88. "Integrated Line."
NAME
ADDRESS
STATE

een supplied to chassis manufacturers nd should be available by the time this ssue is released.

Construction of the unit should commence by mounting the major componnts. To assist you in this regard we ave included top and under chassis hotographs.

The output and power transformers hould be mounted as shown for mininum hum pickup. The power transforner should be stood off the chassis by he thickness of one nut at least to reluce currents induced in the chassis. This is in line with recommendations of he manufacturer.

Before commencing wiring, one special point should be kept in mind. To minimise hum due to earth loops, we have employed a single point earthing technique for the input circuit, and we suggest that you do likewise.

Since the input connectors are necesarily "earthy," the various earth points hould be routed to finish at, or near he input connectors. A liberal use of ag strips should greatly assist in this egard, the earth wires from the early tages making no contact with the chassis long the way.

SHIELDING

Two groups of connecting leads require hielding. These are (1) the leads from he input connectors to the function witch, and (2) the leads from the volme controls to the respective grids. The eads from the balance control to the rids of the 12AU7 would normally be usceptible to hum pickup, but, being xtremely short, may be left unshielded.

Coaxial cable appears to be the most uitable connecting material for shielded eads. Being insulated as well as shieldd, it is particularly suitable for circuits employing a single point earthing echnique, there being no chance of the raiding contacting the chassis.

The wiring technique we have adopted quite straightforward. A liberal use f tagstrips is made to support some of he components, while others are susended between the tagstrips and the ppropriate valve socket pins. Wiring ns are made by means of hookup wire nd spaghetti-covered tinned copper wire.

At no time should overcrowding be difficulty, there being adequate space nder the chassis. However, we do suggest that, when purchasing components, ou select the smallest available, which ill assist you in preserving a neat layut.

VIRING DETAILS

The incoming AC lead is anchored t a three-lug strip, which also supports he transformer primary leads, the inoming earth lead and the low-tension econdary centre-tap lead.

Directly above the transformer (as iewed in the under photo) we have a our-lug strip which supports one end f each of the diodes, the appropriate igh-tension secondary lead and one end f each of the tuner dropping resistor nd its bypass electrolytic.

The remaining ends of the power odes, the appropriate transformer and oke leads and the dropping resistor e connected to the lugs on the electrotics, which are upright types, and one which must be insulated from the assis.

To the right, and almost at the top ntre of the chassis, we have a five-lug rip which supports the tone control iring and the components which swing between the strip and the potentiometer lugs. The topmost lugs support the 68K resistors in the bass network, the 560 pF capacitors in the treble network, and the corresponding leads going to the coupling capacitors.

The next lug down is used as an earth point in the single-point earthing system, the actual earthy lug, which is the following one down, not being used.

To the right again we have the 12AU7 valve socket with a six-lug strip above and a three-lug strip below, held by the socket retaining nuts and bolts. The six-lug strip supports the coupling capacitors and their outgoing leads, the high tension ends of the plate loads and an earth point in the single-point earthing system.

The lower three-lug strip supports the earthy ends of the bias resistors and their bypasses—also earth points in the single-point earthing system. A final earth run is made from these points to the input connector on the rear lip of the chassis.

The second filter capacitor is a dual unit of the upright mounting type. One unit acts as the second filter capacitor while the second unit acts as the decoupling bypass to the earlier stages. The decoupling resistor swings between the lugs of this capacitor.

MAIN AMPLIFIER

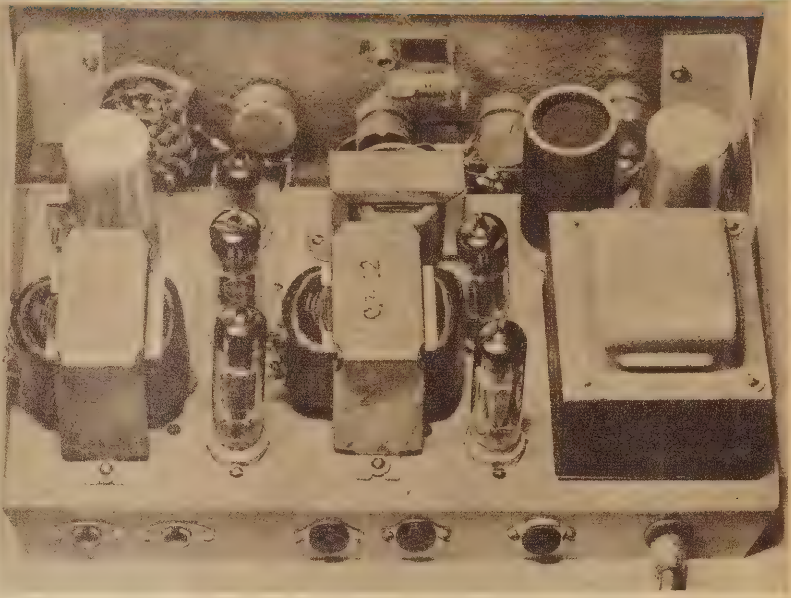
We have now arrived at the main amplifier sections, of which there are two and whose wiring is identical. Here, eight-lug strips are used to support part of the wiring and components, the remainder being connected between the lugs on the strips and the appropriate valve socket pins.

Taking the eight-lug strips, from top to bottom in the photograph, we have the first lug which supports the screen stopper resistor and the appropriate lead from the transformer primary. The next lug down is "earthy," serving as an earth point for the grid and cathode circuits of the output section.

The third lug down is an anchor point for the cathode of the triode driver stage, supporting one end of the bias resistor and its bypass. The fourth lug down is an anchor point for the cathodes of the output stage, supporting one end of the bias resistor and its bypass.

Lug 5 is a decoupled high tension point and is a junction for the plate loads of

LAYOUT OF MAJOR COMPONENTS



This rear view should assist you in mounting the major components. The power and output transformers should be orientated as shown to avoid hum pickup. The positions of the other components are self-evident. Along the rear lip of the chassis we have, left to right, the two pickup inputs, the two speaker sockets and the tuner supply socket.

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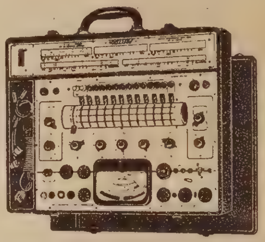

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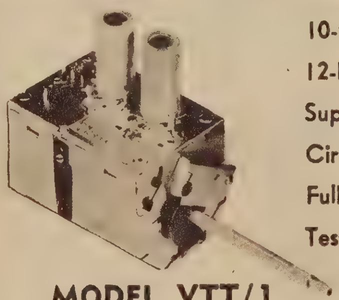

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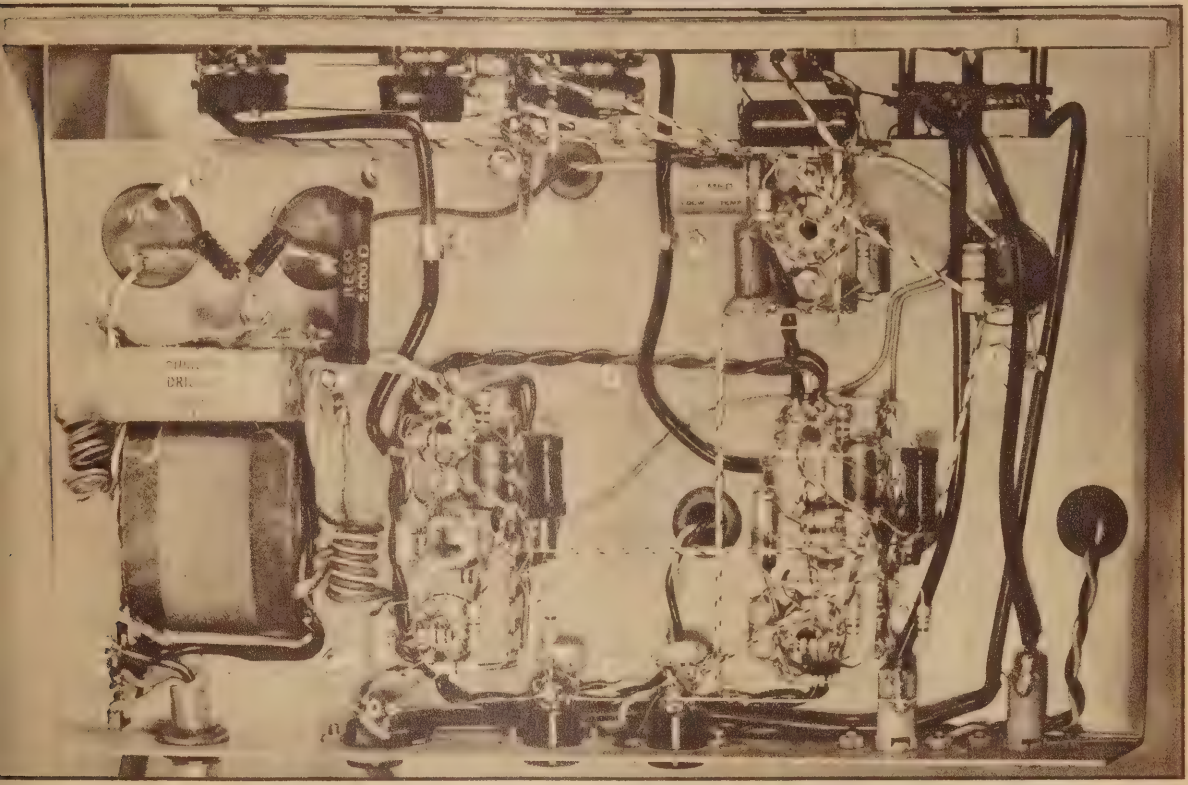
UNDERCHASSIS VIEW — LAYOUT & WIRING DETAILS



This under-chassis view should assist you with the wiring layout, which is compact but not overcrowded. The wiring is conventional, components being supported between tag strips and valve socket pins. The coiled transformer leads have no significance. They are unused leads which we have coiled for the sake of neatness rather than cut them off.

e driver and the phase changer, as well s for the connecting high tension lead the second output section. The step ircuit is also connected between this oint and the plate pin of the driver alve, in parallel with the plate load re- stor.

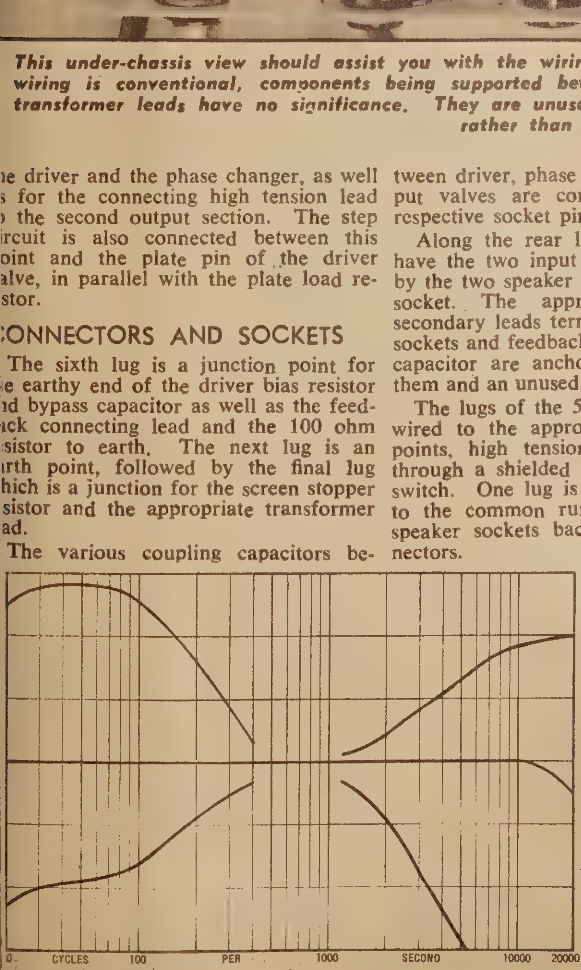
CONNECTORS AND SOCKETS

The sixth lug is a junction point for e earthy end of the driver bias resistor nd bypass capacitor as well as the feed- ack connecting lead and the 100 ohm sistor to earth. The next lug is an rth point, followed by the final lug hich is a junction for the screen stopper sistor and the appropriate transformer ad.

The various coupling capacitors between driver, phase changer and the output valves are connected between the respective socket pins.

Along the rear lip of the chassis we have the two input connectors, followed by the two speaker sockets and the tuner socket. The appropriate transformer secondary leads terminate at the speaker sockets and feedback resistor and phasing capacitor are anchored between one of them and an unused lug.

The lugs of the 5-pin tuner socket are wired to the appropriate heater supply points, high tension supply point and, through a shielded lead, to the function switch. One lug is earthy and connects to the common run made through the speaker sockets back to the input connectors.



☆

This curve shows the response of the tone control stage with the controls at the limits of their settings. The centre curve is the response of the unit with the controls balanced in their flat position.

☆

While on the subject of wiring we would like to mention a point which, although minor, has caused confusion to a few. This refers to our practise of coiling up unused transformer leads for the sake of neatness. We try to avoid cutting them off, in view of possible future use.

Having completed the amplifier you will naturally wish to assess its performance against the original unit. Here are a few voltage and current readings to enable you to do this. The figures are approximate, a few per cent one way or the other being of no special significance, especially in view of the limited accuracy of ordinary multimeters.

VOLTAGES AND CURRENTS

The total high tension measured at the second filter capacitor should be about 250 volts and total current drain, without the tuner, and with no signal input, should be about 125 mA. Between the output plates and earth you may expect about 245 volts, with much the same voltage between the screens and earth.

At the output cathodes there should be about 19 volts of bias; at the triode cathodes, about 1 volt, and at each of the twin triode cathodes about 2.8 volts.

The foregoing information should enable any one to duplicate our results. If the instructions and layout have been followed faithfully, your amplifier will not only look the part, but sound really first class, when fed from a good crystal pickup and into a pair of good speakers.

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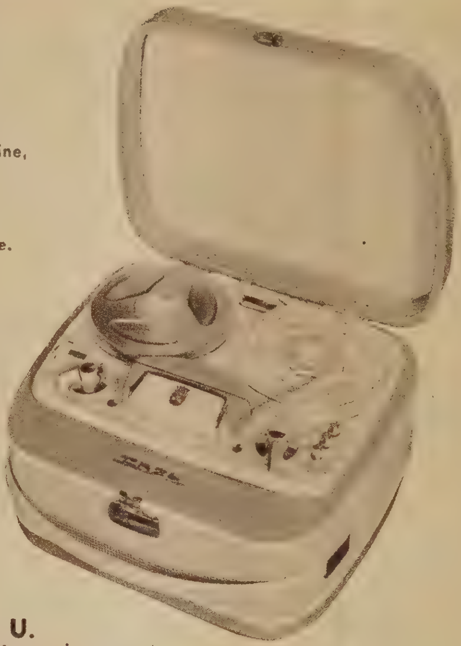

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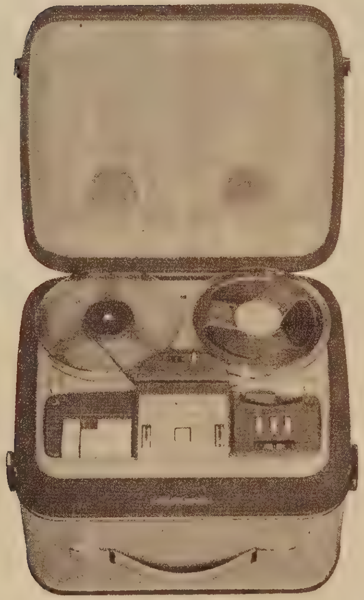

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High performance 3 inch CRO

(Continued from Page 59)

his second valve is the coupling capacior to the output stage.

It is generally advisable to mount the nter-stage coupling capacitors as high ibove the chassis as possible in order to educe stray capacitance to a minimum. This also applies to the capacitors connecting the vertical and horizontal outputs to the CRT plates.

The peaking chokes are mounted inderneath the two 0.27 mfd. capacitors it the vertical amplifier output plates. They are difficult to see in the photograph but are mounted on the five pin ag strip just above the sockets for V3 ind V4.

SHIFT CONTROLS

At the top of the chassis there is a aced set of leads. These are the leads rom the brightness/focus pot. and the wo shifts. They are carrying DC only nd therefore no special precautions are iecessary with regard to strays, etc. The acing simply keeps them in place.

The two pairs of shift pots are at the ery top of the front panel. Each pair s wired in opposition as is indicated in he diagram. This use of ganged pots or the shift circuit is designed to prevent stigmatism by keeping the net deflector late potential equal to that of the final node. If they are wired incorrectly hen the beam will not be deflected and nly the focus will change drastically.

The switch at the back of the brightness/focus pot. is intended for switching off the mains voltage. It was not ired at the time of the photograph so hat the leads would not obscure any omponents.

All the small resistors and capacitors re wired point-to point fashion. There re no needlessly long leads. The filament windings are all twisted pairs and re pressed hard against the chassis. One de of the filament line is earthed — if iere is any hint of hum when the CRO finally checked it may be wise to try irthing the other side of the filament ne instead. However we doubt that ere will be any such trouble.

INAL ADJUSTMENTS

We cannot describe the construction of, id the adjustments to, the complete inrument in this one issue. However, the ajor sections are complete and the CRO ill work as it is.

We have as yet to consider the voltage libration source, which can be either sine wave of known amplitude, proded by a divider across the filament ie, or a square wave formed by a clipng neon tube. The neon provides a uch more constant voltage than the sine ive source and is the one which we ve shown in the circuit diagram.

Also we have to discuss the adjustnts to the vertical amplifier — there the attenuator, with its trimmers, and e checking of the peaking choke values. e will also provide details of the manr of mounting of the graticule brights globes.

Finally there are some suitable probes describe, as previously mentioned, d we will show some typical TV patns photographed from the CRO screen. ese will give a very good idea of its erall performance.

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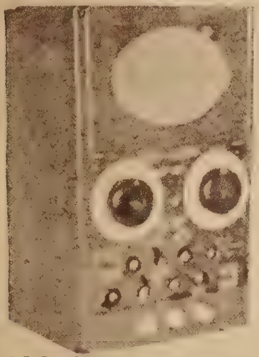

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Let's Buy An Argument

A reader from Bexley, N.S.W., seems to be thoroughly puzzled about "Miller Effect." He can't see it as a fact and is just about ready to believe that the whole idea is some kind of electronic confidence trick. Let's see if we can straighten things out for him—and perhaps for one or two others.

by Neville Williams

This reader writes as follows:

"I have recently been reading about 'Miller Effect' in audio amplifiers, but I just can't see it.

"I realise that there must be capacitance inside valves but how does the gain come into it and how does capacitance from grid to plate get to look like capacitance to earth.

"In any case why the M plus 1? Has the 1 something to do with grid-cathode capacitance which would probably be just as large as the grid-plate capacitance?

"I just don't get it!"

Perhaps, at the outset, it would be wise to make sure that everyone knows what the discussion is all about.

In brief, it was observed many years ago and, in particular, by one, Miller, that valves in amplifying stages frequently exhibited a grid circuit input impedance which was more than just a simple function of the valve's natural internal capacitance or inductance.

The example most frequently encountered is that of an ordinary resistance-capacitance coupled audio amplifier, which often behaves as if there were a quite substantial value of capacitance connected between the grid and earth.

As a result, where the relevant circuit impedance is high, a substantial loss of treble response may be evident. This can easily amount to several decibels at 10Kc and is accumulative where the effect is repeated in a sequence of stages. It must always be considered in hi-fi amplifier design.

It has been verified mathematically, tha tinput capacitance due to Miller Effect is equal to the valve's grid-plate capacitance multiplied by a figure M plus 1, where M is the voltage gain o the stage. In other words:—

C (Miller) = Cg-p (M + 1)

This is the part our correspondent jus can't grasp. Well, let's see if we ca devise a means of clarifying the issue

In figure 1a we show a triode with normal grid input and cathode circui but with the plate connected directly t B-plus. Since this latter is usually by passed to earth, the plate in figure 1 can be regarded as being effectively a earth potential as far as signal frequencies are concerned.

GRID-EARTH CAPACITANCE

Therefore, in figure 1a, at least, an capacitance from grid to plate can b regarded as being effectively betwee grid and earth — or in parallel wit Rg. Note this point because, from it stems the answer to one of your queries

Now the circuit shows a signal applied to the grid and, superficially, i might be considered that the grid itsel will not draw power from the signa source, nor, therefore, impose any loading upon it. The only loading woul be that imposed by Rg but, assumin this to be a large value and a pur resistor, the loading effect will be sligh and constant at all frequencies.

In fact, however, there are othe effects to consider, the chief one, fo our present purpose, being the capacitance between grid and plate which results from their physical proximity.

Thus, when a signal voltage is applie to the control grid, current flows vi earth through at least two paths:—

(1) Through the resistive path R and

(2) Through the capacitive path Cg-p

How much current will flow throug the latter will depend not only on th signal voltage but on the order of Cg- and the signal frequency.

SIMPLE EXAMPLE

One might allot arbitrary values b suggesting that, for a given order o signal voltage and frequency and for on unit of grid-plate capacitance, one un of current will flow through Cg-p. Sinc this current must likewise flow throug the signal input circuit, as an immedia resultant of the signal voltage, it mu appear as a capacitive "load current."

Note also that the circuit of figure 1 exhibits zero gain, since there is plate resistor. Therefore, our one un of capacitive input load current occu ler conditions of zero gain, or where — the symbol for stage gain — is ıght.

Consider now the circuit of figure 1a, which a small value of load has been led in the plate circuit, such that the ve now gives unity stage gain. In er words, a given positive swing on grid will produce an exactly equal nd negative—swing at the plate. Thus equals 1.

The changed conditions in the plate cuit do not affect the resistive loading the input circuit, since the loading due purely to Rg, which has not n changed.

LTAGE INCREASE

But think of the capacitive effect.

lthough Cg-p has likewise not been red, the voltage across it is no longer the signal input. Since the plate swings by an amount equal to the swing, but exactly opposite in se, the two combine to double the age across Cg-p. As a result, the ent through it also doubles.

herefore, the same input signal ch produces one unit of current ugh Cg-p in figure 1a, produces two s of current in 1b.

ow, we know why this is so, but signal input circuit, "looking into" valve grid, simply "sees" the effect a given applied voltage initiates a citive current of two units.

is exactly as if Cg-p were now tly double its former value, or g-p).

hus, with a stage gain of 1, the apnt input capacitance is multiplied 2.

further point is that the plate swing ly adds to the voltage across Cg-p, eases the current through it and luces the same result as if its actual citance had been increased. The e of the current relative to the input al is not changed.

ıerefore, it still appears as in figure as a capacitance between grid and n, but now multiplied in value.

EATER GAIN

ıe same reasoning can be applied gure 1c, where the stage gain has assumed at 2. In this case, there ree times the voltage present across and therefore three times the curthrough it. As far as the input it is concerned, the assumed input l produces three units of capacitive nt flow and the grid therefore apto have an input capacitance three its actual physical value.

ıt note how it works out to verify aw stated earlier—that input capace due to Miller Effect is equal to grid-plate capacitance, multiplied by ure which is one greater than the gain.

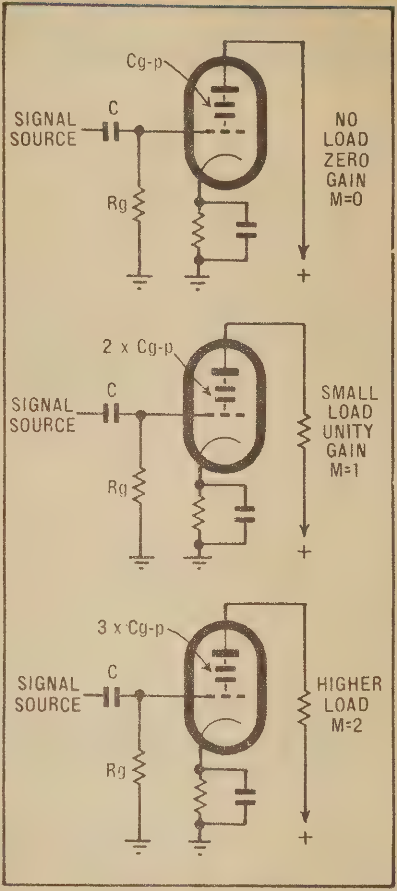
nce the term in the formula, + 1."

making this point, we answered ıer, and, in fact, the only remaining of the original questions.

e "plus 1" relates to the original signal voltage which causes unit nt to flow through Cg-p. The "M" ates the number of times which this current is added to by effects arising the plate circuit.

ıile we are about it, we may as make a few more points relevant e subject.

MILLER SAYS



This diagram illustrates how "Miller Effect" is always equal to grid-plate capacitance multiplied by a figure which is one greater than the stage gain.

The first is that the quantity Cg-p cannot be taken as merely the grid-plate capacitance figure published in valve makers' data for the particular type. It is the total capacitance between grid and plate, no matter how it is constituted.

Therefore, high frequency losses due to Miller Effect may be considerably increased if the presence of the valve socket, the wiring and component layout add significantly to the internal grid-plate capacitance.

Another point is that the letter "M" in the formula indicates the actual gain of the stage in the particular circuit. It is therefore dependent, not only on valve characteristics, but on the applied voltage, plate load and following grid resistor.

To ascertain Miller Effect, it is necessary to determine the true value of stage gain, either by measurement or by calculation or by the use of tables, where these happen to include the particular conditions.

The position is greatly complicated by the presence of any negative feedback loop operating into or around the stage in question.

Take the case of the first valve in a basic amplifier, where, as often, a negative feedback loop injects voltage from the voice coil secondary winding into its cathode circuit. Although the feedback loop does not include the actual signal source, it does reduce the plate swing for a given input signal.

Thus, as far as Miller Effect is concerned, the grid-to-plate voltage gain, or the "M" quantity is less than it otherwise would be. With an effective gain reduction factor of, say, 10 times, the Miller Effect exhibited by a high-mu triode like the 12AX7 may be reduced to negligible proportions, because the actual grid-plate gain figure may be only 5 to 7, not 50 to 70.

Where a feedback loop returns to the grid of the valve in question, it is likely to bring about an artificial reduction of the effective grid input resistance—just as if Rg were shunted by another resistor. The reason behind this is that the natural grid input signal is partially cancelled by the feedback component, so that, for the same ultimate grid swing, the input signal has to supply more energy. In other words, the feedback circuit has lowered the effective grid input resistance.

IMPROVEMENT

If the reduction is sufficient to reduce significantly the total effective resistance of the signal input circuit, it will also reduce treble losses due to shunting by Miller Effect capacitance.

A still further effect is when the stage is completely within a comprehensive feedback loop. In this case the response of the individual stage will suffer from Miller Effect losses, since there is the normal gain relationship between grid and plate signals.

However the loss will be substantially cancelled by operation of the feedback loop. Thus the overall response curve of the total amplifier may be substantially level, even though the response of an individual stage may be lacking.

In seeking to minimise treble losses due to Miller Effect, two courses are indicated:

(1) Avoid valve and circuit conditions where high grid-plate voltage gain is combined with high grid-plate capacitance.

(2) Ensure that the net resistive component between grid and earth is as low as possible under conditions where Miller Effect is likely to be troublesome.

Triode valves exhibit comparatively large values of grid-plate capacitance because the two electrodes are adjacent within the valve.

LOW MU TRIODES & PENTODES

High-mu triodes are most likely to give trouble with Miller Effect, because they combine substantial Cg-p with high stage gain. Where treble loss is to be avoided, the grid-earth impedance of a high-mu triode may have to be limited to a small fraction of a megohm.

Low-mu triodes such as the 12AU7 are much less likely to suffer significant Miller Effect losses in the audio range.

Pentode voltage amplifiers suffer the smallest loss of all because, even though their stage gain may be very high, their inherent grid-plate capacitance is very small, due to the shielding effect of the screen grid. This remark is only valid,

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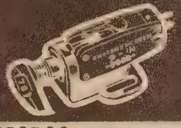

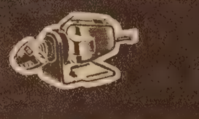

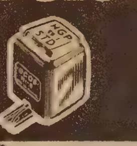

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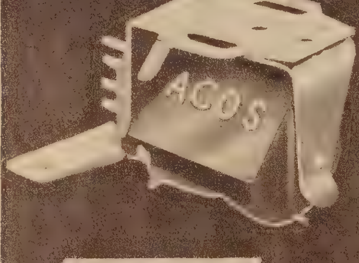

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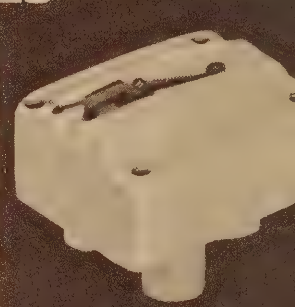

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Figure 2 has been included to clarify r earlier reference to total grid-earth sistance. At signal frequencies, with nich we are concerned, the total re-

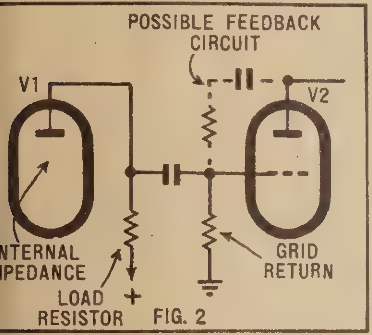


FIG. 2

The total grid-to-earth impedance for V2 is the parallel resultant of several quantities as indicated.

tance between grid and earth is the rallel resultant of the following:

(1) The internal resistance of the preding valve or signal source.

(2) The preceding plate (or other) load istor.

(3) The grid return resistor.

(4) Any "artificial" shunting due, for ample, to negative feedback, as menned earlier.

Provided the total grid-to-earth resistce is lower than the Miller Effect acitive reactance at the highest rered audio frequency, the loss is not ely to be serious. To be precise, and uming that no negative feedback path sts, the treble response will be 3db vn at that frequency where the total acitive reactance between grid and th is equal to the total resistive comnent, as indicated by figure 2.

TENTIOMETER PROBLEM

n general, it is not difficult to achieve ufficiently low value of grid-earth reance when there are several paths ctly in parallel as in figure 2.

ifficulties are much more likely to e where a volume control potentioer is involved, as in figure 3. Here grid-earth resistance may be low ugh when the potentiometer is adnt to the full-on or full-off position, it may be embarrassingly high with potentiometer at near mid-setting.

practice significant treble loss may ir when the grid of a high-mu triode ed from a 1-megohm potentiometer igher. A lower value is therefore to preferred, the only problem being a lower value may be completely itable for other reasons.

follows that, in cheap amplifiers, re the design dictates that a crystal -up shall feed into a high-resistance ntiometer and thence into a high-mu le, the treble response may be down than just that dictated by pickup speaker.

d finally, what of the grid-cathode citance, which our correspondent ioned in his letter?

is a relatively small value and has ing to do with the Miller Effect ula. It is not augmented artificially ircuit operation and can be lumped together with other minor "stray" capacitance effects.

In actual fact, if grid-cathode capacitance is modified at all by circuit conditions, it is more likely to be reduced than otherwise.

If the cathode is left unbypassed, a signal voltage will appear across the cathode resistor but in phase with the grid voltage. This reduces the voltage across Cg-k, reduces the current through it and reduces its apparent value, as far as the signal source is concerned.

This is just the reverse of what occurs with the plate circuit and Cg-p.

EXTREME CASE

The ultimate condition is seen with a cathode follower. Here the grid-plate gain is zero, so that Cg-p has only its natural physical value. Something approaching the full signal voltage is present at the cathode circuit, so that only a small difference voltage appears across Cg-k. The current through Cg-k is reduced in proportion so that its capacitance is effectively reduced to a small proportion of its actual physical value.

For these reasons, the cathode follower is notable for its low input capacitance.

From another reader comes a valve question which is quite a classic, but which probably warrants repetition. He writes as follows:

"Would you please throw some light on the following mystery?

"A 6AC7 valve has a mutual conductance of about 10 MA/V.

"With a plate load of 100K, in theory, a signal of 1 mV. on the grid produces a change in plate current of 10 uA. This, in turn, produces a change in plate potential of 1V. Hence there is a gain of 1,000.

"In practice, however, the gain is nothing like that. Where is my reasoning wrong and how does one calculate the approximate order of gain to be expected from a resistance coupled stage?

"Yours faithfully, S.M."

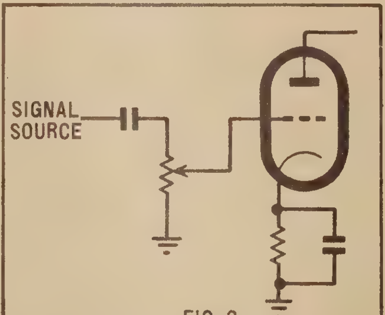


FIG. 3

Miller Effect capacitance is most likely to be troublesome where the grid of a high gain triode is fed from a high resistance volume control.

Well, S.M., your assumption that theory does not work out in practice is based on certain half-truths, plus some other factors, which you have not taken into account.

First of all the transconductance of valves is not a fixed quantity, but varies with the plate current.

High-slope valves like the 6AC7 do have transconductance figures of around 10mA/V—but at plate current figures of about 10 milliamps! In order for the valve to be passing this much current, it is normally necessary for it to have substantial effective voltages on plate and screen with—we trust—an appropriate bias voltage so that it can operate as a class A amplifier.

In general, this means voltages of the order of 200 or more on the plate, 100 or so on the screen and about —2 effective on the grid.

Now your example calls for a plate load resistor of 100,000 ohms, while we have just defined the requirements to realise a transconductance of 10mA/V.

Well then, 10 milliamps flowing through a 100,000 ohm resistor would occasion a voltage drop of 1,000. Add this to the 200 odd volts, which would still have to reach the plate, and you discover that the B-plus supply voltage would have to be 1,200 or more!

IMPRACTICABLE

But that's ridiculous, you might say. A supply voltage of 1,200 is quite impracticable, besides which the load resistor would be dissipating 10 watts!

I agree, but—the valve as set up would give very close to the theoretical 1,000-times gain.

In practice, the operating conditions would be nothing like this. You might have a 100,000-ohm load, to be sure, but the H.T. supply voltage would be about 250.

This means that the maximum current which could flow through the plate load resistor would be 2.5 milliamps, even with the valve considered as a short circuit. But it isn't, of course, and, by the time the valve is taken into consideration, the standing plate current is not likely to be more than 1.5 milliamps. If we assume that the transconductance reduces in about the same proportion, we find ourselves with an effective figure of about 1.5mA/V and a very different figure "in theory" for stage gain.

Here then is the main reason for your error, S.M. But there is more to come.

The resistance across which a valve must develop its signal output voltage is not just the physical plate load resistor but is the parallel resultant of the plate load resistor, the following grid resistor and the valve's own internal plate resistance.

LESS THAN THE LEAST

The resultant of these three is, of course, smaller than any one of them and is the figure which should be used when assessing the gain as transconductance multiplied by plate load.

In the case of a pentode the plate resistance is normally quite high and, assuming the following grid resistor to be high in value also, the gain of the stage may be taken roughly as effective transconductance times the plate load resistor.

With a triode, the internal plate resistance, though dependent somewhat on plate current, is usually much lower than the plate load resistor. Any calculation of gain must therefore take it into account but, in any case, its effect is to make the potential gain of a triode much lower than that of a pentode.

From all this, the answer to your second question should be clear enough.

To deduce the gain of a resistance-coupled amplifier, it is necessary first

(Continued on Page 123)

OFF THE RECORD — NEWS & REVIEWS

Being still in hospital, I am naturally unable to offer any record reviews and must therefore be content to write, in a general way, on matters to do with record listening. In particular I want to have something to say about the subject of mono versus stereo.

by Neville Williams

THE thought is given point by a letter just to hand from a reader in Tasmania. It is set out in the panel below and I suggest you read through it carefully and see what he has to say.

As you will see from its presentation, the letter was originally intended for "Let's Buy An Argument" and it would probably have appeared there but for the present expediency. As things are, it fits nicely into these columns.

Perhaps I should begin by saying that the writer, J.C., is not alone in his ponderings, although not everyone may agree with his conclusion. In fact, it is quite inevitable that, having spent money on something new—in this case stereo—one should pause to ask whether the expenditure has been warranted or not.

The answer may be anything from an enthusiastic "yes" to a firm "no."

Quite a few readers have tried to anticipate the position by asking us to decide for them—whether to stick to mono and even elaborate on it or to change over to stereo.

"I have a certain amount of money to spend," they say. "Would I be better advised to spend it on a good mono system or should I spread it to cover a stereo system of somewhat lesser quality."

Without knowing a person very well or being able to gauge their listening habits, their reactions and their resources, it is virtually impossible to answer such a question with any degree of assurance.

It differs only in detail from other possible questions such as "Should I buy a better amplifier, a more expensive pickup, or loudspeaker? Is a separate loudspeaker enclosure worthwhile?"

All such questions seek to evaluate the possible return for a certain expenditure of time and money. But who can evaluate the pleasure which another person will receive from an investment?

The point is, of course, that audio enthusiasts vary so widely in their ide
resources and habits that terms a
values are much more relative than a
solute.

Dear Mr Williams,

After reading your arguments for 10 years I'm finally going to buy one myself—for the majority of people stereo isn't worth the extra expense involved.

Twelve months ago my mono equipment was Ortofon "C" P.U., Garrard 301 trans. turntable, Leak Point One pre-amp, Leak TL 12 Plus amp., Wharfedale SFB3 enclosure (12in, 10in and 5in units). It sounded pretty good as might be expected!

Then this was gradually replaced in stages: (1) a new Decca FFSS P.U.—seemed to give better clarity and less distortion; (2) a second set of speakers identical to those above—a great improvement which to all intents and purposes removed the "orchestra in the corner" effect; (3) another amplifier and a new Leak stereo pre-amp—not the startling improvement in "clarity" or less "listener fatigue," etc., that the journals (including yours) raved about.

Stereo advantages—gives depth and life to choral and large orchestral and jazz works and so is a closer approach to the original.

Points against stereo: (a) Equipment more expensive than monaural; (b) Many "gimmick" records are still being recorded that are most unrealistic and have dead spots in the centre; (c) Lower modulation of recording means lower signal/noise ratio. The noise in many of the best discs is objectional tape hiss; (d) Most furniture arrangements mean the only place for speakers is in the corners and this gives an unnaturally large listening angle of 55 degrees or more; (e) Directionality is evident which cannot be detected at a "live" concert (due to the mics. being too close?); (f) Listening area is unduly restricted, especially in square-shaped rooms; (g) No advantage for small chamber groups, solo pieces in serious music; (h) No advantage in popular music as few people concentrate on this when it's played and to detect the difference between stereo and mono requires concentration (verified by a "mono or stereo" game on guests). Most pop music is only used as background noise anyway.

Thus we are left with stereo as advantageous to those who have time and the money to concentrate on their opera, orchestral or jazz music. What percentage of the record-buying public does this represent? I'd commend a good mono outfit in preference to an average stereo one any day.

Yours faithfully,

J.C.

Some can genuinely appreciate
refinement offered by the best and m
expensive equipment. On others, the d
ference is completely lost.

Some like to own the best equipme
not because they need it musically, b
because it affords them satisfaction to
so.

Based on previous experience—or la
of it—some rate as "high qualit
equipment which others would dism
as mediocre.

Some equipment is enjoyed and us
by the whole family. Other equipme
is appreciated only by an individual a
then only when circumstances permit
use.

BACKGROUND ONLY

Some family groups insist on havi
record-playing equipment but, in pra
tice, treat it as a background to co
versation.

Readers can probably add a few mo
variants to the groups suggested,
drawing on their own circle of acquai
tances.

Depending on the "classification"
the individuals concerned, the purcha
of certain equipment may be a rewar
ing experience or a disappointment
inconclusive.

It may have involved a worthwh
sacrifice, a waste of money or no sac
fice at all.

All these remarks have been gene
in character. They can apply equal
well to the purchase of any new ite
of audio equipment as to the facili
which is currently occupying the lim
light—stereo reproduction.

Well now, let's have a closer look
the letter from J.C. and examine h
reactions from his own particular poi
of view.

Apparently he began by buying a ne
stereo pickup. Result—improved cla
ity and lower distortion, compared wi
the former high quality mono type.

STEREO PICKUP

Apparent conclusion? When purcha
ing new equipment, one may as well bu
a stereo pickup, even if it is likely
be used for the time being for mor
records. Such a pickup will not hav
to be discarded if the system is co
verted later to stereo.

Step two was to purchase another s
of speakers—again rated as an improv
ment.

Apparent conclusion? Plan your cab
net or your furnishings to take anoth
speaker system. Its ultimate additi
will be an advantage, even for mono.

Step three was the addition of the e
tra amplifier channel and here J.C. r
gisters disappointment—the true ster
records didn't sound all that much be
ter than the "augmented" mono repr
duction. But he does admit to quite

when he says, "gives depth and life choral and large orchestral and jazz rks and so is a closer approach to original."

One might ask, "What else or what re could he expect?"

Would not many enthusiasts regard t as adequate reward for their outlay?

Our correspondent goes on, however, list what he considers to be the limita- ns of stereo as applied in the home. 's look at them and make brief com- nt.

OMMENTS

a) More Expensive: Granted. But n J.C. has elected to use consistently ensive items of individual equipment. has not spared expense for mono. y question further expense for an- er admitted step towards realism?

b) "Gimmick" Records, "Dead Spots": immick" is useful as an adjective but s not synonymous with "bad" or "un- irable." Some records condemned "gimmicky" may sound fine and ad spots" may not be evident on gle cabinet equipment or with J.C.'s n speakers pushed closer together n they apparently are at present.

n any case, there is such a profusion stereo records available now that in- iduals should be able to pick records ich will suit their own taste and equip- nt. This is where a study of reviews uld help.

c) Tape Hiss: I will have more to say ut this in a later issue, but it is not uliar to stereo.

d) Room Layout: This is a definite blem, but its solution is governed y largely by the importance attached the sound system relative to the non- ctional items of furniture often found the average living-room.

The furnishing problem is not pecu- to stereo. Rather is it an extension one which already exists, for example, finding room for a separate speaker losure for mono.

Once a "domestic revolution" in fav- of audio has taken place, a pair of metrical enclosures may even be ier to arrange than a single "orphan" t.

RSONAL DECISION

At least half the problem lies in the ial decision to accommodate a worth- ile audio system.

While in the act of writing this article, had a discussion with a professional n who wants a stereo system but ose living-room is filled with period niture. Said he:

"It is quite impossible to introduce commercial equipment and certainly a television set into my room. If I e to choose between those things and niture, it will be furniture any time."

Result? He has elected to buy a port- e system which can be packed up and wed away out of sight, when not ac- lly in use. To many, such a com- mise would be completely unaccept- e.

d) Corner Speakers: Too wide an le is undesirable, as also is too nar- an angle. In some cases, the com- ling urge to put cabinets symmetri- y into corners can be defeated by ting the common wall as a "feature" l, painting it a darker and distinctive our. The enclosures can then be bal- ed "inside" the new colour mass..

oo much trouble? The room pro- ly needs repainting anyway!

(e) "Unnatural" Directivity: This statement is basically suspect since "directivity" in a live performance is largely dependent on one's position relative to the orchestra. It may be confused, however, in unsuitable auditoriums, by an undue proportion of reverberated sound.

Be this as it may, one must further question the tacit assumption that the ultimate goal of recorded music is to recreate the conditions in an auditorium—along with the acoustic limitations which often attend those conditions!

One of the strong contentions of the late John Moyle was that reproduction from a recording was a method of musical presentation, distinctive and in its own right.

IS IT A FAULT?

Careful microphone placement and recording techniques may well present to the ultimate listener more "information," with less distraction, than if he had heard the same performance from any feasible seat in the "average" and often dubious auditorium.

(f) Restricted Listening Area: This is true and only a very small group can share the full benefits of stereo in a small room.

But for serious listening in a home, I would not consider a larger group anyway. Distraction multiplies too rapidly with numbers!

And don't forget that, away from the optimum area, stereo doesn't sound the worse, simply because it is stereo. The full sound content is still heard; only the directivity is sacrificed.

(g) Small Musical Groups: The usefulness of stereo is greatest on material which emanates originally from a source involving "spread," in the physical sense. But this involves all orchestral, band, choir and organ music, along with stage presentations. It involves solo instrumentalists and vocalists, where these are backed by substantial accompaniments.

Taken together, these would surely represent the bulk of catalogued material.

Enough said!

(h) Popular Music: I thoroughly agree that stereo is treated as little more than a "gimmick" in some quarters to stimulate the sales of radiograms. And, to many buyers, the difference between mono and stereo would not be apparent.

But don't forget that, in this field, the difference in price is not very apparent either! Just enough to cover one valve, one inexpensive speaker and a few extra wires and components.

What is or is not worthwhile has to be equated to this fact.

SUMMARY

Such then is J.C.'s letter and my comments in reply. But where does this leave us? What advice would I personally offer—granted all the difficulties of so doing?

Well, if you have a satisfactory radiogram at present, or other record-playing equipment, and if it is used only casually or against a likely background of chatter or dancing—then forget stereo.

Or at least forget it until the equipment is due for replacement.

If you are buying new equipment, then either buy stereo outright or buy (or build) units which will be adaptable for it. You'll probably want it in the long run anyway.

Buy a stereo pickup or, at the very least, one for which a stereo plug-in head is immediately available. Class for class, stereo and mono pickups do not

VERY LOW FREQUENCY RESPONSE

In many cases, the extreme low frequency response of modern amplifiers would appear to be needlessly sustained. It can, however, be rolled off by judicious choice of coupling capacitors.

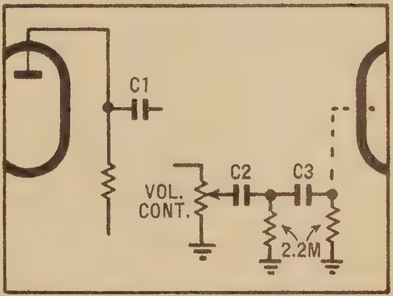
RESPONSE below 30 cps. may well be an embarrassment since the amplifier retains high sensitivity at frequencies where trouble is likely to occur from acoustic feed back, building vibration and motor rumble.

In the main amplifier, the frequency response is usually dictated, as much as anything, by the need to minimise phase rotation within the overall feedback loop. Thus, in seeking the required level response at 30 cps. or thereabout, the actual response is likely to be sustained for one or more octaves below this.

However, low frequency response can be curtailed in non-feed-back type Control Units by a judicious reduction in the value of the coupling capacitors. By causing two or more circuits to roll off over the same range, a fairly steep characteristic can be obtained.

By way of example, in the system described in December last ("Typical Complete Playmaster," page 64), the measured overall response with the original circuitry showed that output dropped by only 0.5 db at 20 cps.

To secure a more pronounced and deliberate low frequency roll-off the coupling capacitor between the valve plate and the control network was reduced and a two-step coupling network added



between the volume control moving arm and the input to the main amplifier.

This involves a coupling capacitor, shown as CI, a following 2.2 M resistor, a second capacitor C3 and the normal 2.2 M grid resistor in the amplifier input circuit.

A suggested combination of values is c C1 .022 mfd, C2 .01 mfd, C3 .01 mfd This produces a response which is 3 db down at 30 cps. and 7 db down at 20 cps.

If C3 is reduced to .003 mfd, the response curve shows 3 db down at 40 cps., 5 db down at 30 cps. and 10 db down at 20 cps. In many cases, this curve would be entirely acceptable and materially assist where motor rumble, etc., is a problem.

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By referring to a chart up to plus 56 db may be measured.

The case is black bakelite with a metal panel 3in meter. Test leads are provided and also a leather carrying case. Sensitivity of meter is 1,000 ohms per volt.

Price of this unit is
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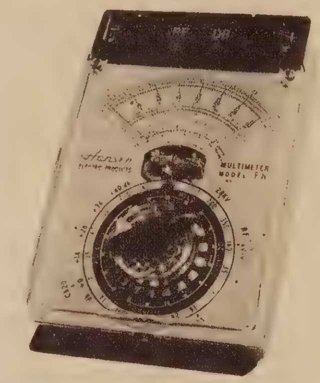

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High Volts 0-1,400, 7,000, 28,000 D.C.; 0-3,500, 28,000 A.C.
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D.B. minus 20 to plus 59.
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Microfarads 0-0.03, 0.6.
Henries 0-5H, 500H.
This meter can also be used to test valve emission and be used for many other tests. The following accessories are supplied with each meter.

1. Standard test leads.
2. 1G probe (non-interference).
3. High voltage probe (1,400V D.C. 3,500V A.C.)
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5. R.F. Lead probe.

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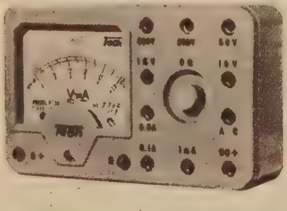

Model PT34. Overall size 3¾ x 2 3/8 x 1¼ inches.

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ay not be available, use of a stereo
ckup will enable you to build up a lib-
ry of stereo records.
Buy a stereo control unit or build one.
en if only one channel is completed at
e outset. A mono control unit is one
em which cannot readily be duplicated
modified for stereo.
The basic amplifier is less of a prob-
m, since this can always be duplicated
a later date.
Where a "unit amplifier" is preferred
-that is one requiring no separate con-
ol unit—buy stereo outright or build
ne, even if only one channel is com-
eted at the outset.

LAN AHEAD

A single speaker system will natur-
ly suffice until the stereo system is ul-
nately installed but look ahead.
Buy a speaker which you can reason-
oly expect to duplicate at a later date.
dd and ill-matched speakers can pre-
dice ultimate results.
If you intend ultimately to have
atching enclosures, buy enough stain,
oth and beading for both at the outset.
Timber and plywood is no problem
ut the finishing touches can be, if the
ecessary items go out of stock at the
rong time.
In other words, and to round things
f, I do not agree with any course of
ction which will commit a genuine
udio fan irrevocably to a new mono
stem.
I think multi-channel sound is here to
ay and individual enthusiasts will not
completely happy till they have it.
herefore, plan towards it, even as a
ng-term project.
Right now it may be out of the ques-
on to invest in a second speaker system,
r example, but the same urge which
ot you one will get you another.
And, finally, if you've been happy thus
r with a good crystal pickup and a
edium-priced speaker, then you'll be
ore than happy with a stereo system
the same standard.
What's more—and in this context I
sagree with J.C.—you'll be happier
ith the stereo version of what you've
own to like, than if you spent a lot of
oney on high quality mono, and got
uck with it!

REVIEW—SQUELCH

(Continued from Page 25)

there is trouble making the relay cut
f, check D3 because, if it is leaky in
e reverse direction, it will tend to keep
e valve biased on.
Threshold control is best achieved by
e rf gain control, since this way it is
ot necessary to add a hole to the re-
iver panel. Otherwise, the circuit of
g. 4 is suitable. But, if it is necessary
cut a hole, you should try to get the
aximum benefit from R7 and use it for
rf gain control. This is especially true
noisy areas when you are using
layed AVC, because the squelch circuit
ll open long before the AVC circuit
gins to work. This insures maximum
nal-to-noise performance.
The circuits shown were tested on an
ammarlund SP-600-J receiver (Super
o), but there is no reason to believe
ey won't work elsewhere. Another ap-
cation of this circuit might be found
a Conelrad alarm system.
—(Radio-Electronics, June 1960.)

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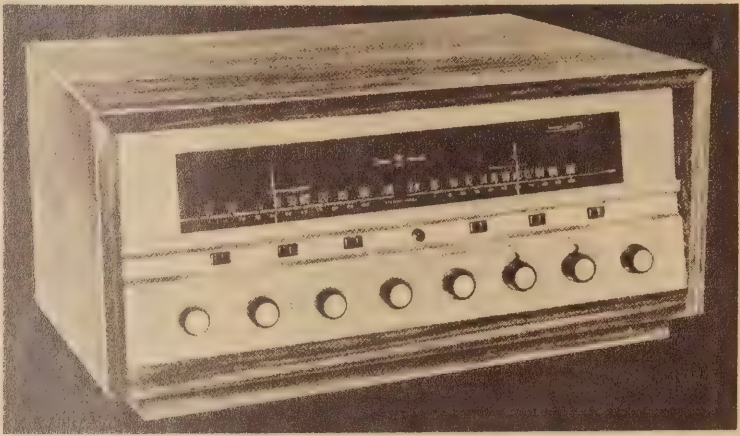

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"The Stereo Festival," Model TA230 illustrated, £296/15/, tax included. Finish—Copper and black.

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"The Sonnet" Model T230. Stereo AM/FM Tuner. Similar to tuning section of the "Stereo Festival." May be used with any amplifier available. Self-powered. Finish—Copper and grey. **Price £128/10/.**

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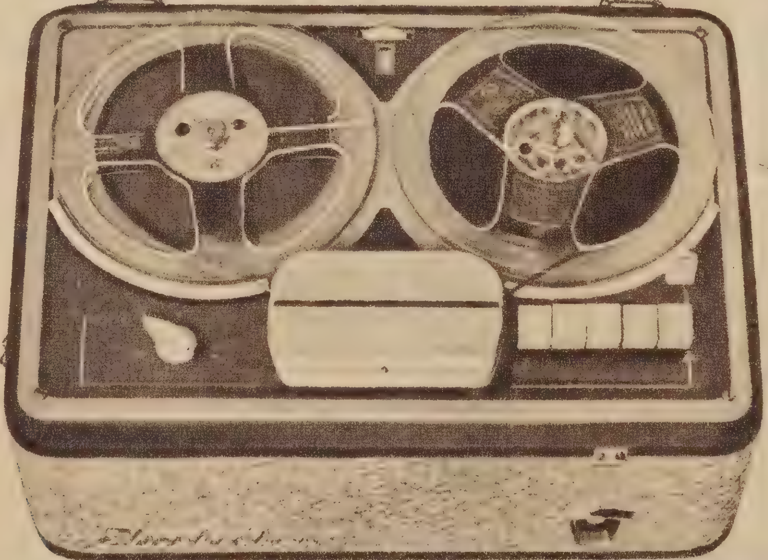

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IN REVIEW—By JULIAN RUSSELL

TWO VERSIONS OF CARNAVAL

Schumann — Carnaval, Op. 9; Fantasia in C Major, Op. 17. Played by Annie Fischer. Columbia Mono 33CX1664.

Schumann — Carnaval, Op. 9; Fantasiestucke, Op. 12. Played by Ania Dormann. RCA Mono L16217.

These two performances of Carnaval iffer vastly. Although Schumann was n arch-romantic, too effusive an approach to his music trivialises it. And have seldom heard a more gushing nterpretation than Miss Dorfmann's. er rubatos plunder some passages to dd their playing time to others. She requently embarks on a new sentence ithout having completed the thought xpressed in its predecessor.

Miss Fischer never displays this emoional shallowness. Her playing is alays ardent but never perfervid. And, espite her intellectual discipline, none f the poetry of these charming pieces vades her. I found hers a deeply satisying performance.

Where Carnaval consists of a suite f miniatures, the C Major Fantasia ttempts the grand manner, and often omes close to reaching it. In this Miss ischer broadens her style appropriately ithout sacrificing any of the composer's impulsiveness. It makes a splenid coupling for Carnaval.

Miss Dorfmann's Fantasiestucke—Des bends, Aufschwung, Warum? Grillen, n der Nacht, Fabel, Traumeswirren nd Der Ende vom Lied—show the ame interpretative extravagancies as er Carnaval. The piano tone on the olumbia is richer and more faithful han RCA's which tends to be sharper nd shallower.

★ ★ ★

Schumann—Concerto for Piano and Orchestra in A Minor, Op. 54. Played by Svjatoslav Richter and the Symphony Orchestra of the Warsaw National Philharmonic, conducted by Witold Rowicki.

Introduction and Allegro Appassionata (Concert piece for Piano and Orchestra in G Major, (Op. 92): Novelette in F Major, Op. 21, No. 1; Toccata in C Major, Op. 7. Piano solos by Richter, orchestra as above. DGG Stereo. SPLM 138077.

Schumann—Concerto for Piano and Orchestra in A Minor, Op. 54. Played by Solomon and the Philharmonia Orchestra, conducted by Herbert Menges.

Grieg—Concerto for Piano and Orchestra in A Minor, Op. 16. Played by Solomon and the Philharmonia Orchestra, conducted by Herbert Menges. HMV Stereo OASD 272.

The concerto is Richter's first rerded performance that has not cometely entranced me. Although he ever indulges in the exaggerations jected to in Miss Dorfmann's recital oticed above, his rubatos might seem many listeners just a trifle overone—especially in the brief slow movement. Moreover in his enunciation of the first subject of the first movement he makes tiny little pauses, repeated every time the melody reappears, that may not be to everyone's taste.

But I hasten to add that these are only minor blemishes on what is otherwise a splendid account of the work. I was, however, not always happy about the balance between soloist and orchestra, which occasionally places the piano too far in front of the accompaniment to allow unobstructed hearing of essential orchestral phrases.

Solomon

But I listened to the reverse side with unmixed pleasure. In the seldom-heard Introduction and Allegro the balance is perfect and the sound generally more forward. And, as I have written elsewhere, if anyone can play the Toccata better than Richter I have yet to hear it. I never imagined it could be made to sound like this with only two hands.

Solomon's performance of the Schumann Concerto, to me, comes as close to perfection as anyone can reasonably expect. His simple, unaffected phrasing is never less than elegant and his undemonstrative presentation of the work reminds me of Cortot's during the middle 1920s. I must confess to feeling more comfortable in it than in Richter's, perhaps because Solomon's is the way I have been used to hearing it played for so many years.

Another factor that contributes to my preference for the Solomon disc is its better balance between soloist and orchestra, and better balance between the orchestral instruments themselves, especially when helped by a slight bass boost. Solomon's recorded piano tone is a trifle lighter than Richter's.

The Solomon performance was issued on mono a few months ago. Good though it was it is now much improved in two-channel form.

Coupled with the Grieg, this makes one of the most desirable piano concerto records I know.

★ ★ ★

Rachmaninoff — Concerto for Piano and Orchestra in C Minor. Op. 18. Played by Svjatoslav Richter and the Symphony Orchestra of the Warsaw National Philharmonic, conducted by Stanislaw Wislocki. Six Preludes for Piano played by Svjatoslav Richter. DGG Stereo SLPM 138076.

For this performance by Richter I can find nothing but unstinted praise. I am not overstating when I describe it as the most exciting I have ever heard—including Rachmaninoff's own. Richter plays with a seemingly inexhaustible variety of tonal inflections and tosses off the most difficult bravura passages like simple scales.

His rhythms are always buoyant, his phrasing has all the ease and polish of cultivated speech, and his general treatment of the work ennobles it throughout. And in this concerto the balance between soloist and orchestra is faultless. Wislocki supplies an inspiring accompaniment.

I think that with the exception of the G Minor which has acquired the nickname of The Cossacks' March, the Piano Preludes will be unfamiliar to most listeners, though pianists among them might know one or two. But even the hackneyed G Minor will astonish its most jaded audience coming, as it does here, from Richter's magic fingers. And the other five are all delivered with the same peerless tone and technique.

★ ★ ★

Brahms—Symphony No. 1 in C Minor. Played by the Philharmonia Orchestra conducted by Otto Klemperer. Columbia Stereo SAXO 2262.

This superb performance which received world-wide acclaim when it appeared last year on mono is enhanced by its transfer to stereo. The only blemish on its otherwise faultless sound is a slight tendency to shrillness in the top notes of the violins. But this apart it is English stereo engineering at its most impressive—wide, deep, rich and transparent.

Klemperer's Brahms readings are now familiar to most of his admirers and need no boost from me here. But for those who may not yet have heard any I might briefly state that the C Minor is typical of them all—weighty, propulsive, sternly correct yet passionate. A very slight surface prickle can be detected during some of the quietest bars.

★ ★ ★

Gershwin — Rhapsody in Blue. Leonard Bernstein at the piano and conducting the Columbia Symphony Orchestra.

Gershwin — An American in Paris. Played by the New York Philharmonic Orchestra conducted by Leonard Bernstein. Coronet Mono KLL 1615, Stereo KLLS 1615.

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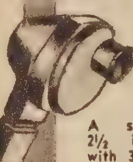

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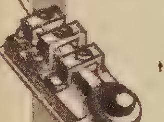

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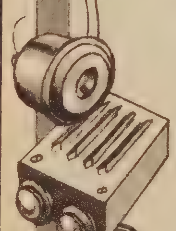

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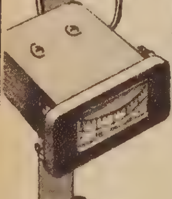

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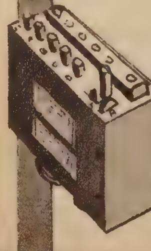

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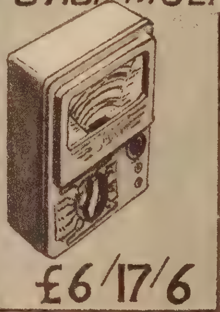

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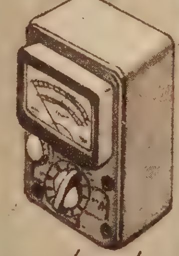

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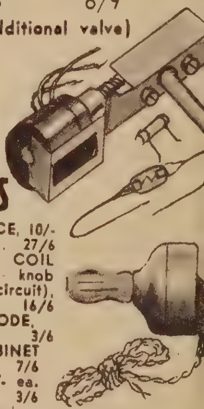

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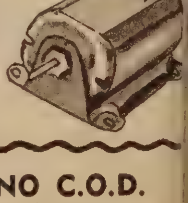

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**Gershwin — Rhapsody in Blue.
layed by the Boston Pops Orches-
a with Earl Wilde, pianist, con-
ucted by Arthur Fiedler.
Gershwin — An American in
aris. Played by the Boston Pops
rchestra conducted by Arthur
iedler. RCA Mono L16223, Stereo
L16223.**

ince Bernstein's is an extremely sub-
ive performance readers must de-
for themselves whether it pleases
offends them. Personally, I found
voluptuous approach to this bright
ic overdone. In order to exploit the
grain of sentimentality in the score
takes many of the tunes at a snail's
e. His woodwind soloists, undeni-
accomplished though they are, go
great pains to impress.

ernstein himself plays the piano solo
solid merit. And Coronet's sound
ineers have supplied him with an
lent-toned reproduction.

iedler's is a much lighter-hearted,
demonstrative performance, and to
mind, much more in the spirit of
in which the work was conceived.
that reason I prefer the Boston
s' version of both pieces to Bern-
n's, whichever orchestra the latter
ht be using, and I prefer it to
Wilde's less didactic account of the
o part in the Rhapsody.

n mono — good on both labels —
onet loses a little of the advantage
sumptuous engineering gives it on
eo. Bernstein's piano tone is a little
nder than Wilde's heard on one
nnel.

n stereo the extra richness of Cor-
t's sound gives the impression that
slightly better spread than RCA's.
s, however, is illusory. The differ-
e is in the quality of the tone and
in its separation, which is equally
ctive in both.

, like me, you accept the Old Paul
iteman performance which had the
roval of the composer, as a guide
the way the Rhapsody should be
ved, get the RCA. Should you pre-
something rather more ostentatious,
Coronet's should please you.

★ ★ ★

**Symposium — Tchaikowsky's
iano Concerto No. 3 in E Flat
Major, Op. 75; Weber's Konzert-
tuck in F Minor for Piano and
rchestra, Op. 79; Litolf's Scherzo
rom Concerto Symphonique, Op.
02; Turina's Rapsodica Sinfonica.
layed by Joseph Cooper and the
ro Arte Orchestra conducted by
harles Mackerras. Pye Mono
LC 5017.**

ye's sound is not at its best on this
ppointing disc. The piano tone is
sistently unpleasant, and the pianist
to make too obvious an effort to
with the technical problems of
Litolf Scherzo for it to "come off."
does he seem any more at ease in
Konzertstuck, a grand old piece of
when adequately presented.

n the latter he is not helped by
ckerras' contribution. This brilliant
ng conductor seems no more com-
able than his soloist in the midst
his extravagant early nineteenth cen-
romanticism. I had hoped that
ckerras, who recently demonstrated
Australia his great skill in conduct-
modern scores, would find the
ina piece more to his taste. Per-
s it is, but here, too, he and Cooper remain too staid to be interesting and the engineering does nothing to help them out. Now and again in the short Tchaikowsky Concerto Mackerras coaxes some eloquence from his orchestra, but the occasions are too rare to add much excitement to an otherwise routine account of the piece by all concerned.

There was a good deal of distortion in the orchestral tone on my pressing.

★ ★ ★

Beethoven—Piano Sonatas No. 21 in C, Op. 53 (Waldstein) and No. 18 in E Flat, Op. 31, No. 3. Played by Artur Rubinstein. R.C.A. Mono L16220.

Rubinstein's may not be a deeply thoughtful performance in the Schnabel manner of the popular "Waldstein" Sonata, but it is beautifully pianistic. I found it entirely delightful though I do not expect those who insist on a more conventional style of Beethoven playing to agree with me.

Rubinstein seems unconcerned with philosophical problems and deals with the music as a medium for the expression of beautiful sound. And in this he is brilliantly successful. I have seldom heard the notes delivered with such elegance, free, however, from any hint of foppishness. And there is drama in plenty, too, when Rubinstein thinks fit to emphasise it.

I find it difficult to imagine even the most hidebound Beethoven purists objecting to what they hear in the slighter E Flat Sonata. Here all is wit and merriment presented with unfaltering fluency of sound and ideas. The piano tone is excellent in both sonatas.

Leonard Bernstein

FranckJSymphony in D Minor. Played by the New York Philharmonic Orchestra conducted by Leonard Bernstein. Coronet Mono KLC2687.

The orchestral riches of the New York Philharmonic are further exploited in this outstanding example of mono recording. Except for an occasional over-emphasis of the bass, easily corrected by the controls since it is never woofy, the sound is superbly full and resonant. And this is achieved without any unwanted thickening of the middle voices.

This is a work better suited to Bernstein's opulent style—at any rate for those who admire it played "molto expressivo." Technically the playing cannot be faulted if one untidy woodwind entry halfway through the first movement is overlooked.

In the second movement the cor anglais buzzes like a golden bee and the strings in the Bach-like bars that precede the second subject play with inimitable grace and delicacy. A fine vigour characterises the Finale — with one or two very theatrical pianissimos.

All this is fine. Where purists will

If it's

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gree with Bernstein's reading is in
melodramatic changes of dynamics
his over-extended silences. Others,
ever, may find it very impressive,
cially when considered in terms of
sound engineering.

★ ★ ★

**Tchaikowsky—Symphony No. 4
F Minor. Played by the New
ork Philharmonic Orchestra con-
ucted by Leonard Bernstein.
oronet Mono.**

his Coronet disc is also outstandingly
neered. Bernstein takes the opening
s theme very slowly and moves on
"waltz" tune that creeps in, so to
k, but soon picks up speed to reach
ore normal tempo. The sentimental
oon that follows sounds quite ludi-
sly lovesick and the cellos match
sentimentality in their counter-theme.
uch of this section goes slower than
l with jerky quick changes adding
spurts to the music. There is some
nificent brassy horn playing using
forced tone known as "cuivres."

he slow movement also moves re-
antly enough to give an impression
umbering. But the pizzicato scherzo,
n at a steady tempo, is a constant
ght. Much of the Finale is taken
-steadily, but you'll find plenty of
r in it just the same.

★ ★ ★

**Miller — Death of a Salesman.
lia Kazan's production starring the
riginal cast with Thomas Mitchell
Willy Loman. Festival Mono
2/3 r.p.m. FTL9004.**

**Fry — The Lady's Not For Burn-
g. Directed by John Gielgud and
arring him, Pamela Brown and
ther members of the original New
ork cast. Festival 16 2/3 r.p.m.
TL9003.**

ome discophiles are prejudiced
nst 16 2/3 r.p.m. reproduction. They
n that quality is sacrificed to gain
extra playing-time. There might be
ase against the slower rate when
ic is recorded, though Festival's
d on the complete Menotti opera
Consul," issued last year, prom-
I thought, speedy solution of some
e slow speed's musical problems.

these two spoken plays such ob-
ons have no significance. The re-
ing quality is splendid, right up to
spindle. And if it's lengthy playing-
you're after, the discs run 86 min-
each.

oth plays have been skilfully adapt-
or sightless enjoyment and both are
lly acted.

one of the wit is missed in the Fry
all the tragedy retained in the Mil-
I do think, however, that while one
njoy constant replaying of a favour-
nusical disc, a spoken play might
its interests after very few repeti-
. But I can guarantee that you will
eld by them the first time through.

★ ★ ★

**Tchaikowsky — Selections from
ballet Swan Lake. Played by
Utah Symphony Orchestra con-
cted by Maurice Abravanel.
stminster Stero WG-W-S-18080.**

is is the first recording I have heard
e Utah Symphony Orchestra and its
ty makes one wonder just how
fine bands there are in the United
. The Utah perhaps lacks the bloom
characterises the playing of the
's greatest orchestras but it is very
none the less.

avanel manages the mechanics of the attack and release with commendable skill and never places himself too prominently between the composer and his audience. His phrasing is shapely and his dynamic changes always governed by good taste. I would have appreciated a little more rhythmic freedom in some of the items and the overlong pauses between them hold up the progress of the work.

Otherwise it is all eminently pleasing and the stereo sound is always well spread and nicely in perspective. A slight surface sandiness is noticeable on my pressing.

★ ★ ★

Dvorak — Slavonic Dances for Piano Four Hands, Op. 46 and 72. Played by Afred Brendel and Walter Klein. Vox Mono APL-11620.

Many of these dances will be familiar to musicans in their orchestral form although they were originally composed for the combination used here. I must confess at the outset that I personally find them more exciting played by an orchestra. But these two young pianists give an excellent account of them, even if the effect suggests an engraving of a richly-coloured original.

Their co-ordination is perfect, sometimes at the expense of rhythmic elasticity. And they always seem to be in such perfect control of themselves and each other that a little of Dvorak's fire is quenched in favour of cool precision. The result is playing that is undeniably elegant but a trifle too impersonal for my complete enjoyment. Admiration, yes.

★ ★ ★

Beethoven — Missa Solmnis in D Major, Op. 123. Elisabeth Schwartzkopf (soprano), Christa Ludwig (mezzo-soprano), Nicolai Gedda (tenor), Nicola Zaccaria (bass). Singverein der Gesellschaft der Musikfreunde. Philharmonia Orchestra conducted by Herbert von Karajan. Columbia Mono 33CX 1634/5.

I prefer the soloists in this set to those on the other two I have heard—Toscanini's and Klemperer's. And the choir, too, leaves little to be desired. Karajan misses no point of the great drama and controls his forces with unquestioned authority. Yet the overall effect left me vaguely unsatisfied. And this was not entirely due to a balance that moves the soloists from the front to the back of the orchestra while always keeping the chorus in good perspective.

I think the reason for my disappointment was because, in these days of a reliable stereo technique, this work is still offered with all the limitations imposed on it by single-channel reproduction. In the absence of any stereo version I recommend this set as the best available on mono, realising at the same time that others may prefer the Toscanini interpretation despite the improved sound in the Karajan.

★ ★ ★

Delius—Incidental Music to Hassan; Arabesque; Over the Hills and Far Away. Played by the Royal Philharmonic Orchestra with the B.B.C. Chorus conducted by Sir Thomas Beecham. Coronet Mono KLC 2691.

It was Beecham who first introduced Delius' music to the English public, and nowadays he is almost alone among the great conductors to remind them it still exists. For after a brief period of popularity Delius has almost disappeared from concert programs.

This is difficult to understand because Delius' music is not difficult to listen to, and much of it has great charm. Perhaps an explanation can be found in the fact that most of his works end quietly, and this type of close seldom produces enthusiastic applause in a concert hall where the loudest endings unfortunately create the most excitement.

Charles Burr in his sleeve notes accompanying this disc observes that "'Over the Hills and Far Away' (is) one of the rather rare examples of Delius' music that ends fortissimo," and it is to be hoped that this factor might help popularise a charming concert.

Beecham, always incomparable in his Delius readings, once again demonstrates here his affection for and understanding of the music. He makes "Over the Hills and Far Away" a warmly joyous experience finishing with as exciting a climax as any concertgoer could desire.

The Hassan music is presented complete, 11 items in all, with Leslie Fry in the baritone solos, and Arthur Leven and Frank Riddle playing the violin and viola solos respectively. Despite the expressive singing of Mr Fry and the chorus I found the words very difficult to make out and this fault persists in Arabesque, where Einar Norby is the baritone soloist.

Otherwise, except for occasional unsteadiness in Mr Norby's tone, I can recommend this as good, if not vintage, Delius to those who are interested. Beecham presents it with all his customary elegance of phrasing and inflection and the mono engineering is first rate. Coronet has no plans for a stereo issue.

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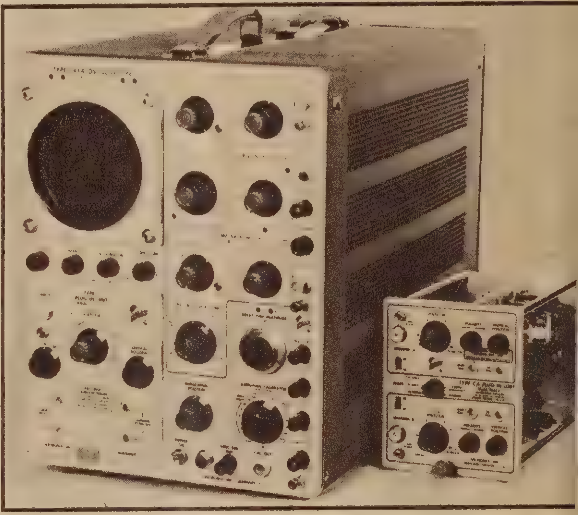
TRADE REVIEWS AND RELEASES

"TEKTRONIX" CRO—WIDE RANGE OF FACILITIES

A sample from the highly esteemed "Tektronix" range of oscilloscopes was recently sent to our laboratory for inspection and review. Designated as type 545A it is essentially a laboratory type instrument, and almost certainly the largest and most versatile we have ever described in these columns.



☆

Here is the 545A "Tektronix" CRO. A fast rise-time type L pre-amp is visible in operating position, with a dual-trace type CA unit alongside. Very high quality and easily read controls are features of the instrument.

☆

MEASURING 13in x 16¾in x 24in and weighing 65lb the instrument hardly falls into the "portable" class, but this is no disadvantage for a unit of this type.

The basic instrument (less Vertical Preamplifier) has 77 valves (most of which are double purpose types) and 6 semiconductor diodes, which gives a good indication of its size.

The unit is normally supplied with a 5BHP2 cathode ray tube, operated at 10 Kv EHT, but tubes with other phosphors can be supplied to order. The C.R.T., incidentally, along with many special components in the instrument, is manufactured by Tektronix themselves.

A major feature of the instrument is the vertical pre-amplifier system. This is in two sections, an inbuilt "last half" and one of no less than nine specialised plug-in units. In addition there are three other plug-in units; a transistor characteristic plotter, a vertical calibrator, and a time base.

Typical of the pre-amplifiers is the type "L," a fast rise time, high gain unit and, with it, the overall response of the vertical system is quoted as DC to 30 Mc, with a rise-time of 12 milli-microseconds and a sensitivity of from 5 millivolts per cm. While we have not the equipment to accurately check this, we found that by observation of a T signal the performance is quite as go as these specifications would imply.

There are two timebases in the ur one covering sweep speeds of 0.1 mic seconds per cm. to 5 seconds per cm. 24 accurately calibrated steps, and t other covering sweep speeds of 2 mic seconds per cm. to 1 second per cm. 18 steps. A 5 times magnifier is fitt effectively dividing these figures by and by an ingenious intercoupling of t two timebases portions of the trace c be magnified by up to 10,000 times.

In addition, one timebase can be us as a variable trigger delay for the oth while the vertical amplifier includes delay line after the trigger take-off observation of leading edges of puls Both timebases are Miller Run-Up C cuits, with very reliable and versa triggering and linearity circuits. Gat signals are provided at the front of instrument for timing external equ ment with the two timebases.

MORE FEATURES

There are many more features p vided in this instrument, such as the built 1,000 cycle square wave amplitu calibrator, the variety of plug-in p amps available, handy electron-beam a control position indicator lamps, ed lit graticule with adjustable illumi tion and many others. So many, in fa that we would need much more spa than is available here to do it justice.

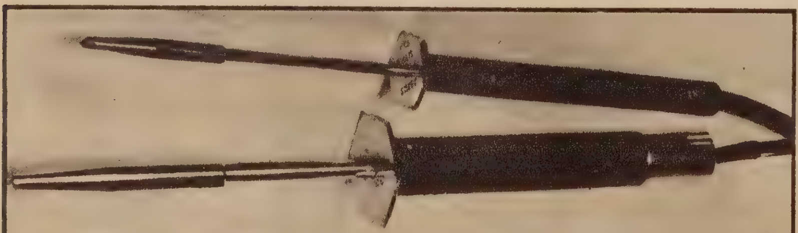
We need hardly emphasise that workmanship and finish of this inst ment is of the highest order and, su ming up, we would say that the en "system" is a logical choice for a organisation where the very best p formance is the prime requirement.

The model described was supplied the importers, Electronic Industries I ports Pty. Ltd., of 121 Crown Str East Sydney, to whom all inquiries garding "Tektronix" Oscilloscopes a associated equipment should be direct

TWO USEFUL LIGHTWEIGHT IRONS

TWO 6-volt irons recently released to the trade are the Mico Lightweight Irons, made by Mico Electric Pty. Ltd., and both embody a number of interesting features.

A major one is the method of fitting the soldering bit, whereby the heating element is virtually enclosed within the bit, thus making maximum use of the available heat and, at the same time, helping to keep heat away from the handle.



Another feature is the bit itself. Made from copper for maximum heat conduction it is chrome plated to minimise oxidation, always a problem where irons have to run for long periods in factories.

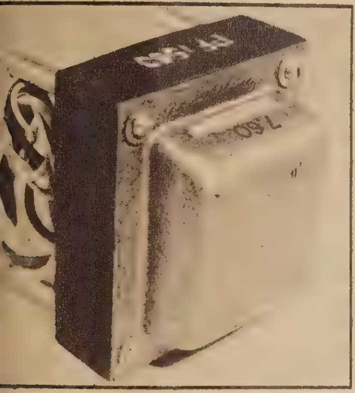
Two models are available at the present time, a 10-watt type and a 20-watt type. The 10-watt type is intended for very fine work where only a minimum amount of heat is needed. It uses a 3/16-inch diameter solder bit and weighs 1oz.

The 20-watt model is for more standard working. It has a 3/8-inch diameter bit and weighs 5oz.

One model of each iron has been in use in our own workshop for several months, and each has performed extremely well. They would appear to substantiate all that the makers claim for them.

Retail prices are 56/3 for the 20-watt model and 50/ for the 10-watt model. They should be available from all trade houses, and the N.S.W. distributor is Watkin Wynne Pty. Ltd., 21 Falcon Street, Crow's Nest, N.S.W.

FERGUSON C.R.O. TRANSFORMER



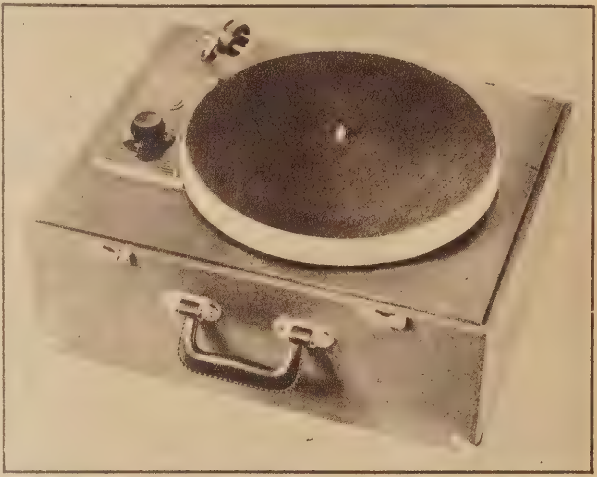
**THE transformer pictured above has just been released by Fer-
guson Transformers Pty. Ltd. De-
ignated as type PF 1563, it is a
mall low-leakage-flux tvpe especial-
y designed for small oscilloscopes.
The usual system of a copper "short-
d turn" strap is used to m'nimise
tray radiation.**

The transformer is provided with a
in secondary of 250-0-250 volts at
milliamps and two 6.3 volt heater
dings, one at 3 amps and the other at
amp rating. Primary taps are for
, 240 and 250 volts.

As shown in the photograph, the trans-
mer is provided with four pillars to
ble it to be mounted away from the
ssis, allowing good ventilation and
noving the necessity for cutting a hole
the chassis. This was designed par-
larly for the small CRO appearing in
issue, but should prove very suitable
all low radiation applications.

ROLA QUALITY TURNTABLE

The professional quality turntable pictured below has recently been released by the Rola Company (Aust.) Intended mainly for broadcast-applications, the unit should also be of interest to all serious record reproduction enthusiasts, due to its high quality and performance.



Here is the new Rola turntable, mounted in a portable demonstration case. Precision manufacture and quality performance are a keynote of the unit.

PROVIDING all four standard speeds, the unit features a synchronous motor and a precision-ground cast aluminium turntable weighing 4¾lb. The manufacturers quote a wow and flutter figure of less than 0.1 per cent, measured on a Gaumont-Kalee meter from Decca test record at 33 1/3 r.p.m. We were unable to check these figures, but the unit appears exceptionally smooth and quiet in operation.

The turntable bearing consists of a precision ground phosphor bronze insert let into the cast aluminium base plate, with a thrust bearing consisting of a very accurate ball bearing. The turntable itself has a hardened steel centre into which fits the spindle.

The motor is a four pole synchronous type and consumes 25 watts. The speeds are arranged by a four-step motor pulley, with a precision ground rubber idler wheel transmitting torque to the machined inner edge of the turntable. The speed change knob has a disengaged position between each speed and the motor is turned off in each of the disengaged positions, making accidental formation of idler wheel "flats" unlikely. (i.e., one must disengage the idler to stop the turntable.)

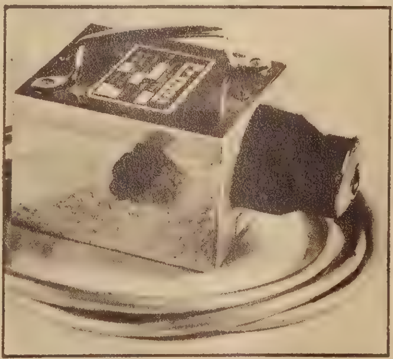
The motor is also mounted on rubber, to further decrease vibration and rumble. The table height is 1 3/8in above the mounting panel, and the actual table is 12 9/32in in diameter.

The retail price of the unit is quoted as £76/8/10, and it may be obtained from Mastersound Sales, 400 Kent Stret, or direct from the Rola Company (Australia) Pty. Ltd., Caltex House, Kent Street.

SMALL IRON TRANSFORMER

**THIS well-made unit is a "Pryman" soldering iron transfor-
ner, intended for all nominal 6 volt
rons of up to 20 watt rating.**

'itted with a switch to adjust the out-
, voltage (standby, normal and fast-
t using 5, 6, and 7.5 volts), it was
inally made for the "Mico" irons
ewed elsewhere in this issue. It will
vailable from normal trade suppliers,
g distributed by Messrs. Watkin
ne Pty. Ltd., 21 Falcon Street,
w's Nest. The trade price is 50/ plus
per cent sales tax.



NEW "PRODIS" SWEEP ASSEMBLY RELEASED

READERS who are contemplating the construction of the latest R, TV and H. Sweep Generator will be interested in a new sweep assembly recently released by Prodis Electronic Instruments. Designated the Type VSU/1 Sweep Assembly, the unit allows alignment of both sound and video IF strips in television receivers.

The assembly incorporates a magnetic sweep unit similar to the original VU/1 unit used in the generator, with the addition of a second pair of coils which are switched in to shift the centre frequency to 5.5 Mc/s for sound IF alignment. The complete assembly includes all the RF wiring and the range switch.

The price of the unit is quoted as £12/10/ plus 12½ per cent sales tax, and supplies should be obtainable from normal trade suppliers.

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●

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Kit contains all coils, Ferrite rod or Aerial Coil, I.F.'s and audio transformer. (When ordering, please specify Aerial Coil or Ferrite loopstick).

All components are fully tested to specification, exactly as supplied for the original model receiver.

Alternatively, items may be purchased singly.

Type No.		s. d.
718	Tuned Ferrite Aerial Rod and Coil	17/6
719	High Gain Aerial Coil	17/6
739	Oscillator Coil	9/10
729	R/F Coil	10/8
919	455 K.C. I.F. Transformer double tuned, each	16/9

No extra for Sales Tax.

Type No.		
524B	Driver Transformer	17/6
4301	Output Transformer for 3 ohm. Voice Coil	17/6
	Additional coils for Short Wave 7-24 Mc/s Range.	
7191	S.W. Aerial Coil	10/8
7260	S.W. R.F. Coil	10/8
7302	S.W. Oscillator Coil	10/8

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ELEMENT . . . Moulded carbon composition.

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BOOKS-REVIEWS AND COMMENTS

N INTRODUCTION TO ATOMIC ENERGY, by W. G. Atkinson. lication No. 271 by John F. Rider Stiff paper cover, 68 pages, 9 x

his book is based on lecture notes, inally prepared by the author in his as lecturer to the staff of the Elec- Boat Division, General Dynamics poration.

hough deliberately non-mathematical intended to serve those with only a ted prior knowledge of physics and nistry, the book manages to cram a rising amount of information into 8 pages.

eginning with an explanation of basic icles, it veers rapidly toward isotopes radiation.

n this basis, chapter 2 explains the re of nuclear reaction, followed by ore detailed discussion of fission.

hapters 4 to 6 outline various prac- types of reactor, the nuclear air- t jet, design problems and materials.

final brief section covers the his- of atomic energy research.

brief, this is a book which can ecommended to everyone with an in- st in radio or popular science, who t to fill out their background in the ction of nuclear physics.

ur copy was received direct from the lishers but supplies should be avail- through local technical booksellers. N.W.)

* * *

ECTRONIC BUSINESS MACHINES, edited by J. H. Leveson, . (Econ.), A.C.I.S., M.B.I.M., with ributing authors. Hard cover, 272 es, 9 x 6in. Published in London, 9, by Heywood and Company Ltd.

lectronic business machines and com- rs in general have developed so rap- that most electronic engineers have a vague idea of their operation. same applies to business executives, might be expected to have some ap- iation of what is now possible in field.

here is therefore ample room for books aimed at bridging the gap and is one such book.

ased on a course of lectures deliv- at the Dundee Technical College, rovides an introductory study of the ication of electronic computers to strial and commercial situations.

here are three main sections as r:— Programming for business pur- s; Business management and elec- ic data processing; Computer equip- t and application.

general, the text centres on the tory where electronic engineers and ness management now have to meet both could learn much from its s. Though a good deal of applica- may be necessary to absorb the de- the material is presented in a high- adable form and supported by block natic diagrams.

way of example, one chapter ex- s how computer techniques and hed cards were used, at the close of World War II, to work out the complex system of air routes which form the basis of present-day international airline operation. Without such aid and using ordinary office personnel, the task of rationalisation would have been almost insuperable.

Our copy from the Technical Book and Magazine Company Pty. Ltd., 295-299 Swanston Street, Melbourne. Australian price 64/9. (W.N.W.)

* * *

TRANSISTOR PROJECTS. Gernsback Library Book No. 89. Stiff paper cover, 160 pages, 9 x 6in.

According to the publisher's notes, this book is aimed at readers who are keen on building things rather than on spending a lot of time on transistor theory.

In keeping with this, the book contains very little of transistor theory, as such. However it does contain an opening chapter on transistor misconceptions which was written, I gather, by someone who is rather partial to semi-conductors.

After that, it plunges straight into some 30 projects, including radios, instruments and accessories and "miscellaneous."

These are extracted from recent issues of "Radio-Electronics," having been developed and described, in the first instance, by authors of proven ability.

For the most part, the projects are small and rather "gadgety," so that the appeal of the book will be mainly to those who like fiddling with simple circuits, for the fun of so doing.

Our copy came direct from the publishers but supplies should be available in due course through technical booksellers. (W.N.W.)

* * *

BASICS OF INDUCTION HEATING, by C. A. Tudbury. Vol. 1, 140 pages, Vol. 2, 144 pages, 9 x 6in, stiff paper cover. Publications No. 247-1 and 247-2, John F. Rider, Inc.

As Chief Engineer of the New Rochelle Thermatool Corp., the author of these two volumes has a very close connection with the whole subject of induction heating. He is therefore able to quote figures freely for work-size, power and frequency, where another author may have to be content with more general terms.

The subject is presented in a highly pictorial fashion, the total space being about equally divided between the text and hundreds of drawings. Being free of complex mathematics, this method of presentation should appeal to readers with electrical or mechanical training who want to extend their knowledge into this relatively new and expanding field.

Volume 1 starts with the subject of eddy currents and examines the relationship between heating coils and practical work-pieces, including tubes, solid rods and those of less regular shape.

Volume 2, which would appear to be an essential companion book, has exactly the same format but deals mainly with sources of induction energy — the motor generator, inductor alternator, line frequency heating and valve oscillators. Heating coils are discussed further and control systems.

In brief, the two books should constitute an excellent introduction to the subject at "trade" level.

Our copies came direct from the publishers but supplies should be available locally in due course. (W.N.W.)

* * *

F.M. SIMPLIFIED, by Milton S. Kiver, third edition. Hard cover, 376 pages, 10 x 6in. Published 1960 by D. Van Nostrand Co. Ltd., London.

This third edition of F.M. Simplified follows closely the two earlier editions but has been revised and brought into line with present circuit techniques and commercial equipment.

The subject is covered in a very logical and easily readable form, so that the book would be an excellent text for anyone wishing to learn something of this particular field.

The main concern of the author is with F.M. as applied to high fidelity sound broadcasting, though much of the basic discussion applies equally well to narrow band F.M. and television sound.

Opening chapters cover the general principles of frequency and phase modulation and the generation, propagation and reception of F.M. signals.

Then follows a chapter by chapter discussion of tuners and receivers and the stages which constitute them.

Separate chapters are devoted to alignment and servicing and to typical commercial F.M. tuners. Circuits are included for these.

Toward the end of the book, some 40 pages are devoted to F.M. transmitters, with further reference to commercial units.

Our copy came direct from the publishers but supplies should normally be available through technical booksellers. (W.N.W.)

* * *

TELEVISION ENGINEERS' POCKET BOOK, 2nd Edition, by J. P. Hawker and contributing authors. Hard cover, 264 pages, 7 x 4½in. Published by George Newnes Ltd., London.

This new edition, enlarged to cover the ramifications of I.T.A. transmissions on Band III, is a veritable mine of information on the British television system.

Beginning with British standards and networks, it progresses through a general discussion, on viewing to basic circuitry for the picture and sound sections of a receiver. Suggestions are given for converting to Band III operation.

There are chapters on installation, aerials, interference problems. Other chapters cover servicing, service equipment and alignment, together with mis-

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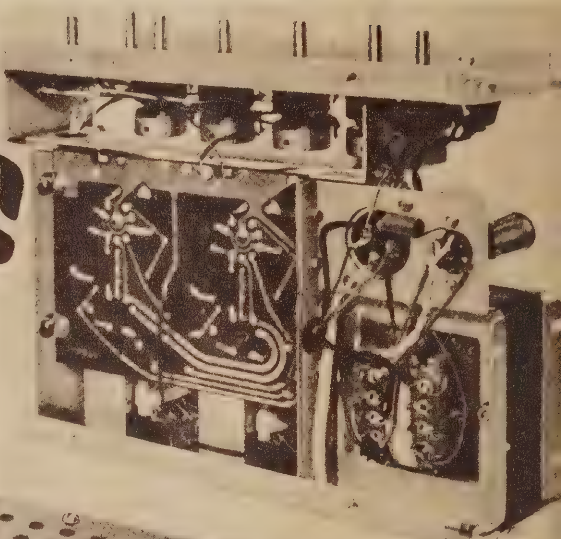

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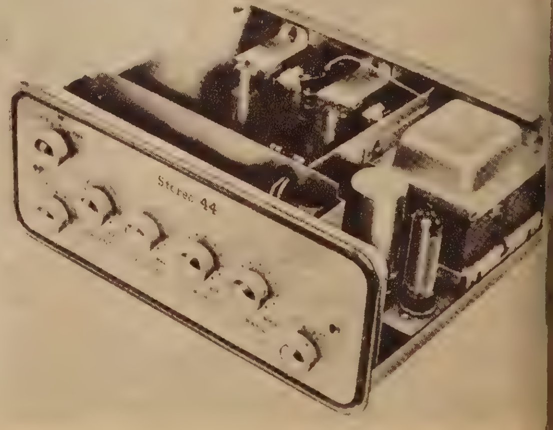

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BOOK REVIEWS AND COMMENTS

laneous data on valves, picture tubes l other components.

Jnfortunately, by reason of the very at difference in transmission stand- ls, only about half the text has any plication to Australian receivers. erefore, its greatest use is as a record "how the other half lives."

Our copy from the Technical Book l Magazine Company Pty. Ltd., 295- 9 Swanston Street, Melbourne. Aus- lian price 20/9, plus 1/3 postage. .N.W.)

* * *

RACTICAL WIRELESS SERVICE MANUAL, 11th edition. Hard ver, 8in x 6in, 301 pages, with 241 strated. Edited by F. J. Cann, re- ed by A. T. Collins.

ntended more or less as a guide for tyro serviceman, this book would o be very handy for home experi- nters and others who wish to build, rate and understand test instruments. ll constructional details of most com- n test instruments are given, as well information on commercial instru- n's and their capabilities.

Although the book is written with English situation in mind, most of circuits and information it contains perfectly suitable for Australian con- ons. Such things as valve equiva- ts are liberally supplied in the book, that little difficulty should be experi- ed in modifying circuits to our stan- ds.

Besides dealing with test equipment l its use, the book has quite a section oted to simple tests on electronic gear l general servicing procedure. It uld be quite handy on the test bench.

Published by George Newnes Limited, London, the book sells in Australia 34/9, plus 1/6 for postage. Our y was from the Technical Book and gazine Company Pty. Ltd., of 295- 9 Swanston Street, Melbourne. (J.R.)

* * *

ADIO CONTROL FOR MODEL BUILDERS, by William Winter. ft cover, 228 pages, 5½ x 8½ in. Contains many photographs, circuits and diagrams.

This is a well-written book of the "how-to-do-it" class. It explains in clear language the full story on model radio control, dealing with principles, practical points and operational procedure, as well as constructional data.

For the newcomer to electronics, there are chapters on various aspects of the subject relevant to radio control. Thus, we find chapters entitled "Transmitters," "Receivers," "Meters," "Relays" and "Power Supplies."

A section is devoted to the distinction between escapements and servos as actuating elements, and many commercial examples of various types are pictured and discussed. The installation and operation of radio control apparatus on model boats, planes and cars are dealt with separately to enable the special problems of each application to be explained.

Our copy was from the publishers, John F. Rider, Publisher, Inc., of 116 West 14th Street, New York, N.Y., and the Australian price is not yet known. (J.R.)

* * *

BASICS OF FRACTIONAL HORSEPOWER MOTORS AND REPAIR, by Gerald Schweitzer. Soft cover, 6 x 9 inches, 176 pages, contains diagrams, circuits and photographs.

Intended as a guide for the operation and maintenance of the many types of fractional horsepower motors used in domestic appliances and similar equipment, this book should prove very handy to hobbyists. It appears to cover adequately most information required by those wishing to use, rebuild or repair motors commonly encountered.

After a brief section on the basic principles of the electric motor, the book devotes chapters to the operation of Split-Phase, Capacitor Start, Repulsion-Induction, Shaded Pole, Universal and Three Phase Induction motors. The operation, torque, characteristic and special features of each of these motor types is explained in a very clear, easy-to-read style, aided by clear diagrams.

Further sections are devoted to the methods of mounting and enclosing the various types of motor, and the types of winding used. The procedure for testing for faults in motors is explained, and a chapter is included on the care and maintenance of fractional horsepower motors in general, with special features of various types mentioned.

Finally, chapters are given to the discussion of various motor control and protective devices, the principles of operation and typical circuits being given. Although the book deals naturally with American motor types and power conditions, it is quite universal and very suitable for Australian conditions.

Our copy from the publisher, John F. Rider, Publisher, Inc., of New York. The Australian price is not yet available. (J.R.)

DECIMAL CURRENCY OR £.s.d.

(Continued from Page 15)

To undertake the calculation in £.s.d. means remembering that there are 60/ in £3 and 36d in 3/ and also it involves division into larger numbers than are found in the decimal calculation.

The decimal calculation has less steps, all of which are straightforward.

To reconcile the mixed mathematical breakdown of £.s.d to the simple decimal system has been an objective for many years.

In the early half of the nineteenth country a Bill proposing decimal currency in Britain was introduced in the House of Commons. Again in 1847 the matter was raised and on this occasion a motion was carried introducing the florin (or one-tenth of a pound) as a first step towards decimalisation.

In 1853 another select committee reported in favour of decimal currency, and during the 1860s the dies were actually made for minting the new coins. Endorsements also came from influential groups in 1893 and 1917, and in 1918 bills were introduced into the House of Lords on currency reform, but no decisive action resulted.

Australia has undertaken its own investigations, and the present inquiry is the fourth major inquiry over the past 60 years.

In 1902 a Select Committee recommended in favour of decimal currency. In 1926 the Empire Decimal Association, with Sir John Monash as patron, urged the adoption of decimal coinage. The Royal Commission on the Monetary and Banking System in 1937 made a similar recommendation. None of the recommendations was adopted.

New support for a change to decimals came in 1957 when the Victorian Employers' Federation sponsored formation of the Decimal Currency Council. This group recommended to the Government that an inquiry be set up, and early last year the Federal Cabinet formed an expert Decimal Currency Committee.

The committee's terms of reference require it to make an estimate of the annual savings in cost to the community accruing through putting money on a decimal basis. It has also been asked to estimate some of the costs of a change-over, as well as to propose how the currency should be decimalised and the new system introduced to minimise inconvenience.

Commentators have emphasised the mounting costs to be faced if the decision to change is delayed. Because Australia is growing and monetary machinery is being introduced at such a rate, the cost and inconvenience of any change to decimal currency is increasing constantly.

To change to a new system of currency in a highly-organised society is a difficult and complex task, but it is generally held that the very considerable benefits to be derived from a simpler monetary system far outweigh the disadvantages.

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REMEMBRANCE DAY CONTEST DETAILS

The Remembrance Day contest is conducted by the Wireless Institute of Australia and since 1948 has been held annually in memory of amateurs who fell in World War II.

THE contest is conducted each year on the weekend nearest the anniversary of V.P. Day, August 15. It is held to perpetuate the memory of the Australian Radio Amateurs who gave their lives for their country in World War II.

Their names and call signs are engraved on the trophy which is awarded annually to the State Division of the W.I.A. which compiles the highest score.

A special opening ceremony takes place prior to the commencement of the contest and the names and call signs of the fallen are read.

THOSE ELIGIBLE

Amateurs throughout the Commonwealth and its territories are especially invited by the W.I.A. to participate in the event. Details and rules are as follow:

Objects: Amateurs in each call area (this includes those in Australian Mandated Territories and Australian Antarctica) will endeavour to contact amateurs in all other call areas (VK1 and VK2 are considered to be one call area).

Date: 13th and 14th August, 1960.

Duration: From 1800 hours, E.A.S.T., August 13, 1960, to 1759 hours, E.A.S.T., on August 14, 1960. A period of silence will be observed by all stations on August 13 immediately prior to the start of the contest, when an appropriate broadcast will be made from VK3WIA and relayed by divisional stations.

Rules:

1. There shall be four sections to the contest—

(a) Transmitting phone.
(b) Transmitting CW.
(c) Transmitting open.
(d) Receiving open.

2. All Australian amateurs may enter the contest, whether their stations are fixed, portable or mobile, but only members of the W.I.A. are eligible for awards. Portable/mobile operation is defined as transmitting and/or receiving equipment which is not connected to any private or public power mains or plant.

3. All amateur frequency bands may be used, but no cross band operations are permitted.

4. Amateurs may operate on both phone and C.W. during the contest (e.g. phone to phone, C.W. to C.W. or phone to C.W. and vice versa), but may submit an entry for only one of the above sections listed in Rule 1.

An open log will be one in which points are claimed for both phone and C.W. transmissions.

MIXED PHONE AND CW

A contestant transmitting on phone but receiving on C.W. must enter for the phone section (and vice versa). Refer to Rule 11 concerning entry in logs.

5. Only one contact per station per band is allowed and arranging schedules for contacts on other bands is not permitted.

6. Only one licensed amateur is permitted to operate any one station under the owner's call sign. Should two or more operate any particular station, each will be considered a contestant and must submit a log under his own call sign.

Contestants operating stations othe
than their own shall be referred to fo
the purposes of these rules, as "subst
tute operators."' Their operating pro
cedure will be as follows:

Phone contacts: Substitute operato
will call "CQ Remembrance Day," fo
lowed by the call sign of the station the
are operating and the word "log," fo
lowed by their own call sign.

C.W. contacts: Substitute operators w
call "CQRD de" followed by the grou
call sign comprising the call of the st
tion they are operating, an oblique strol
and their own call sign.

WORKING SUBSTITUTE OPS.

Contestants receiving signals from
substitute operator will qualify for poin
by recording the call sign of the subst
tute operator only.

7. Entrants must operate within th
terms of their licences.

8. Cyphers: Before points may
claimed for a contact, serial numbe
must be exchanged and acknowledge
A five-figure serial number for pho
and six-figure for C.W. in accordan
with the usual practice must be use
R.S.T. (C.W.) plus contact number thr
figures and R.S. (phone) plus conta
number of three figures.

9. Entries must be set out using o
side of the paper only and in followi
order: Date and time E.A.S.T., Ban
Emission, Call Sign, Number Sent, Nu
ber Received, V.H.F. Bonus, Poi
Claimed and a blank space. Entri
must be postmarked not later than Se
tember 4, 1960, and addressed to t
Federal Contest Committee, W.I.A., B
851J, G.P.O., Hobart, Tasmania.

10. Scoring will be as follows:

VK0 to VK1/2 — 6 points and
points for contacts to any other ca
areas. VK1/2 to VK0—6 points, VK3-
VK4-2, VK5-3, VK6-5, VK7-4, VK9-
VK3 to VK0—6 points, VK1/2-1, VK
3, VK5-2, VK6-5, VK7-4, VK9-6. VI
to VK0 — 6 points, VK1/2-1, VK3-
VK5-3, VK6-6, VK7-5, VK9-4. VK5
VK0 — 6 points, VK1/2-2, VK3-
VK4-3, VK6-5, VK7-4, VK9-6. VK6
VK0—6 points, VK1/2-1. VK3-
VK4-4, VK5-3, VK7-5, VK9-6. VK7
VK0 — 6 points, VK1/2-2, VK3-
VK4-4, VK5-3, VK6-5, VK9-6. VK9
VK0 — 6 points, VK1/2-1, VK3-
VK4-3, VK5-4, VK6-5, VK7-6.

BONUS

In addition, a bonus of 25 points m
be claimed for the first contact w
each call area on 50 mc/s and above.

11. Logs shall be set out as shown a
in addition will carry a front sheet sho
ing the following information: Nan
Section Entered, Address, Call Si
Score claimed, also a signed declarati
that the rules and spirit of the cont
have been observed. All contacts ma
during the contest must be shown in
log submitted (see Rule 4). Entra
in the open section must show pho
and C.W. contacts in one numeri
sequence.

12. The right is reserved to disqual
any entrant who, during the contest, h
not observed the regulations or who

HIGH SCHOOL RADIO CLUBS ACTIVE

The Vaucluse Boys' High School Radio club is firmly established and club meetings are held on Tuesday afternoons after school hours and every lunchtime constructional work is done by members. The Headmaster, Mr Keith Harris, has made a classroom available for club activities and power points and benches have been installed. Their callsign is VK2AVV and the station is gradually taking shape and equipment has been donated by various helpers.

The members are at various stages of progression in the radio field. Some progress has been made in the developing of a series of practical and theoretical tests for which certificates of proficiency will be awarded. It is their aim to make the first contact with Brother Kinsella's Club at Christian Brothers' College, Lewisham. It is hoped other schools will develop the Radio Club idea and build up a schools' radio club network.

The school radio club is a well-established institution in American schools and colleges. There is no reason why a similar program should not be developed in this country—what a potential for an influx of young persons to the amateur bands.

The club is unfinancial and no charge is made to members and any amateurs with surplus equipment may be able to assist. The transmitter (ex VK2YA) is ready to operate but lacks 7mc/s crystals. If any amateur who has progressed to V.F.O. usage could spare a "rock" it would be greatly appreciated. Donations of any type of equipment would be acceptable. Rex Black, VK2YA (English-History Master) is in charge of the venture and communications could be directed to Rex at the school of his home QTH.

nsistently departed from the accepted de of operating ethics.

13. The ruling of the Federal contest mmittee of the W.I.A. will be final. dispute will be entered into.

14. Awards: Certificates will be award- to the winners of the phone, C.W., en and receiving sections in each area orthern Territory will count as a sep- ate call area). There will be no out- ht winner for Australia. Further cer- cates may be awarded at the discre- n of the contest committee.

The State to which the Perpetual ophy will be awarded shall be deter- ned in the following way: To the aver- e of the top six logs shall be added bonus arrived at by adding to this erage the ratio of logs entered to the ate licencees, multiplied by the total ints from all entries. Acceptable logs all show at least five valid contacts.

STENERS ONLY

Receiving section: Open to all S.W.L.s Australia. Logs should be similar to ose for transmitting entries. Logs must ow first the call sign of the station ard (not the station being worked), the ial number sent by it and the call n of the station being worked.

Points will be claimed in accordance th the scale provided. It is not suffici- to log a station called CQ. A tion may be logged only once on each nd. Certificates will be awarded to highest scorer in each call area.

A.R.R.L. Report

The A.R.R.L. in a QST editorial point out the advantages to amateurs generally of a reduction in power input, especially for short-haul working. The W's of course can use legitimately IkW input while their neighbours the VE's are permitted 500 Watts output (about 700 Watts input). The League points out it is ridiculous to use the full gallon for cross town working and propose the installation of small transmitters or the big rig less the final for such contacts. With over 200,000 licensees in the U.S. QRM is an ever-increasing problem, hence the general appeal to use the minimum power requirement for any contact. They also point out a little known clause in their Communications Act—Section 324. In all circumstances except in case of radio communications or signals relating to vessels in distress, all radio stations including those owned and operated by the U.S. shall use the minimum amount of power necessary to carry out the communication desired.

There is a lot of merit in the idea but in this age it would be a pity to see the DB's over S9 disappearing.

Decisions at the 1960 meeting of the A.R.R.L. board of directors provided items of interest. Noteworthy was the resignation of the League's secretary and general manager, A. L. Budlong, W1BUD, effective from the end of the year. Bud had served the league for 37 years. His successor will be John Hun-

DIVISIONAL NOTES AND ACTIVTIES

New president of the N.S.W. division the WIA, Bill Lewis, VK2YB, is well own to amateurs. Active since the late his fist has been heard on all bands ecially by a host of overseas stations 14 mc/s. Bill has held many offices the WIA through the years and amat- s wish him well in a position that exacting and requires much time. Ted iting, VK2ACD, the retiring presi- t had worked hard on institute affairs it is hoped he will be able to make comeback to an executive position.

New councilor for the division is rold Burtoft, VK2AAH, well known his discourses on transistors. He tured to the June N.S.W. general eting on a Transistor Mobile Modu- r. By the use of duplicated notes Har- made the talk even more interesting. sent at the meeting was Hugh, eroHA on his way back to Holland. gh was very active from Dutch New nea on the DX bands. He told of scarcity and high cost of equipment that area. An amateur licence costs 2 the first time up and then £5 a .

fter a discussion at a special meeting awson attended by the N.S.W. divi- vice-president, Max Pleffer, VK2MP, VHF section president, Bob Winch, 2OA, and members of the Blue ntains section of the WIA, it was de- d that the section would form a EN Co-ordinating Committee for the e. The meeting was held at the home section president, Keith King, ABK.

he section's station VK2AUX will sed for control under a controller o be selected. A 144 Mc/s link will provide the contact with VK2WI and Sydney as required. The arrangement is a new departure from previous operating procedure and has merits, providing separte control from VK2WI and an opportunity for a country section to assist the division generally.

The July meeting of the VHF and TV group N.S.W. division saw Bob Winch, VK2OA, lecturing on the use of Hybrid valves in mobile equipment. Later, last year's president, John Lark, VK2ZAV, presented the chairman's trophy for that year to Jim Cummings, VK2PM.

Gil Miles, VK2KI, over a July VK2WI broadcast, spoke at length on the part radio amateurs could play in assisting in radio astronomy work. Amateurs were invited to attend a meeting of the Sydney Astronomers' Society at Belfields, Sydney, to hear a discussion on such matters. Gil assured amateurs who desired to co-operate that they would receive assistance from both professional and amateur astronomers.

President of the Tasmanian W.I.A.. VHF section, is Alan Morrisby, VK7MY. The section was formed earlier in the year at Hobart and 13 members attended the inaugural meeting. Plans were then laid down for future activity, type of lectures, etc. Ken VK7KA lectured at the June meeting and gave a practical demonstration of crystal etching and grinding. Col Wright, VK7LZ, is still looking after notes on VHF activity for the north and north-west of the island. The Athol Johnson Memorial Contest was conducted on 50 mc/s and above. The late VK7AJ was a keen VHF enthusiast and the contest is held to perpetuate his memory.

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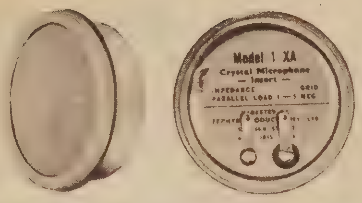

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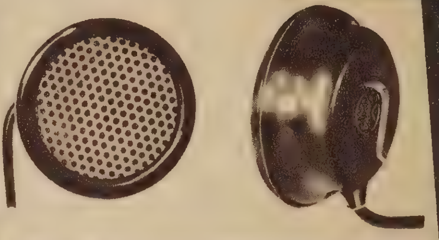

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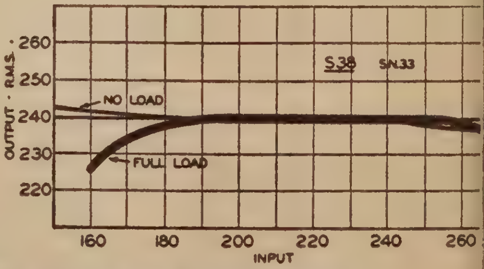

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CNR. WILLIAMS ROAD & CHARLES STREET, NTH. COBURG, VIC. PH. FL12 oon, W1LVQ. The board conferred on im the title of secretary and general anager emeritus to come into force om January 1, 1961.

The board requested league officers continue their efforts to regain operting privileges in the 160 metre band nd to lift the present power limit on ne 420 Mc/s band. They also recomended the use of Greenwich Mean ime by all amateurs and ordered a tudy of usage of amateur bands beween 3.5 and 29.7Mc/s as concerning e various modes of emission.

Family Scheme

The A.R.R.L. runs a scheme for amily membership at a reduced rate. fter one member of a family has beome a full member at the regular dues f 5 dollars other members of the family nay become members of the league on e payment of only one dollar. They ave full rights and privileges but only ne copy of QST goes to the family. t is certainly a good scheme for amateur adio minded families in the U.S. One amily for instance has five novice icences with block calls between N7KSE and KN7KSI—quite a saving or them. There may be some argument bout QST however.

After nearly two years of proceedings e F.C.C. has finally settled the queson of exclusive CW segments on the 0 and 144 Mc/s bands for U.S. mateurs. The F.C.C. originally proosed segments at 50.9-51.0 Mc/s and 47.9 to 148.0 Mc/s and these allocas were strongly opposed by the .R.R.L. and other groups. Most amaurs favoured segments at low edge of ese bands. The final decision of the .C.C. on the CW sections is 50.0 to 0.1 Mc/s and 147.9 to 148.0 Mc/s.

It is expected that by the end of 960 all U.K. and U.S. time and freuency signals will be fully co-ordinated. he scheme was commenced at the beinning of the year in order to help to rovide a uniform system which is reuired in such fields as radio communiation geodesy and tracking of artificial tellites. The various governmental deartments of both countries are coperating and all participating stations ill be transmitting signals emitted in nchronism to the thousandth of a cond by the end of the year.

The stations included in the codination plan are GBR and MSF at ugby, NBA Panama Canal Zone, WV Beltsville, Maryland and WWVH awaii.

News From Antarctica

Active from Antarctica are the followg stations, KC4USA Little America 8deg. S 162deg. W), KC4USB Marie rd Base (80deg.S 120deg.W), KC4USH lsworth Base (77deg.S 41deg.W), C4USK Wilkes Base (66deg.S 0deg.E); KC4USN Amundsen and ott Base at the geographical South le. U.S.S.R stations working from the ctic regions include UAzeroAZ and AzeroBF, Dickson Island, UAzeroIK Pevek on the Arctic Ocean Coast, AzeroKAE at Cape Chelyuskin (76g.N 105deg.E), UAzeroKID at Chuuku on the Bering Sea, UA1KGC changel, UA1KUB Murmansk. In Antica is UA1KAE active from Mirny se.

DL1FF, who has been on sked with Frank Hine, VK2QL and Graham Hall, VK2AGH on 3.5 Mc/s and audible in the mornings was heard on 7 Mc/s at 1400 hrs EAST, the earliest a European has been received on that band. At the time other weak signals were also breaking through. The 3.5 Mc/s band provided plenty of W's in the early evening on the last weekend in June. It was the occasion of the A.R.R.L.'s National Field Day and all bands were crowded.

The A.R.R.L.'s DXCC Honour Roll is at a very interesting stage especially in the CW section in the race for the 300 country mark. Chas. Mellon, W1FH, and Jock White, ZL2GX, have now 299 countries confirmed. Close by are W6AM and W3GHD with 298. A total of 37 amateurs have tallies of over 290 countries. In the telephony section PY2CK leads with 294 countries, in second place VQ4ERR with 291.

If you are interested in rarer wines the Portugal National Society in co-operation with the Port Wine Institute provide an interesting award. To obtain the award it is necessary to contact 9 stations in specified provinces in Portugal and with each award goes a bottle of genuine Port.

The Northern Californian DX Club Inc. offer the Californian Award to all amateurs outside the 50 states of America. QSL's from 220 different Californian stations are required including 20 from members of the NCDXC.

QSL's may be certified by officials of recognised amateur radio societies and clubs. Full particulars may be obtained from P.O Box 75, Oakland, Calif., U.S.A.

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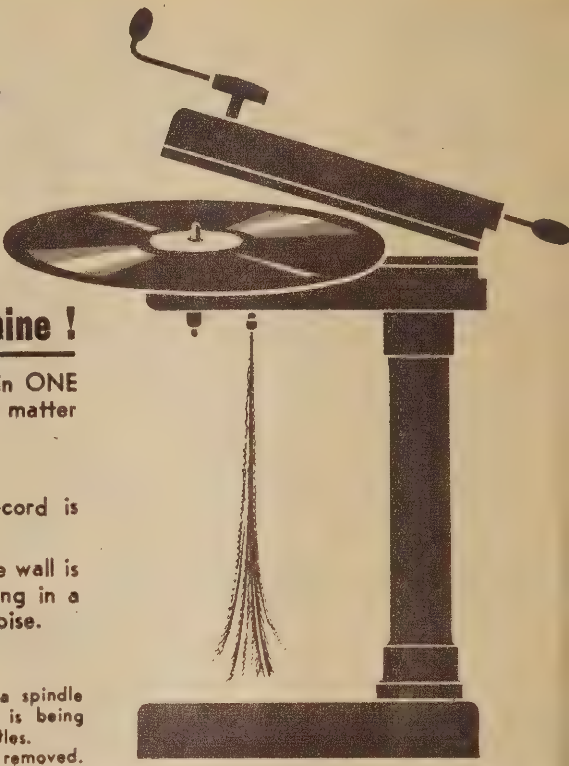

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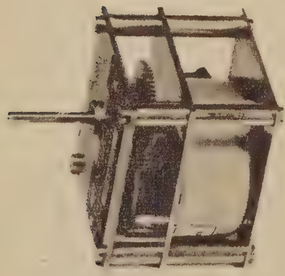

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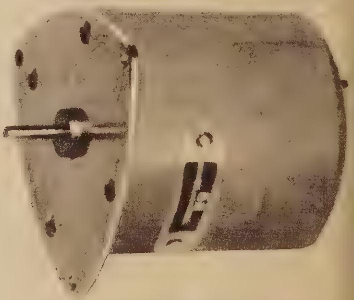

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ON SHORTWAVE BY ART CUSHEN

00 Kw VOA STATION BEING BUILT

The biggest short wave broadcasting centre in the world is now under construction for the Voice of America in North Carolina, U.S.A.

HE new station is now under con- struction, and when it is built at eenville, North Carolina, the Voice have the largest and most powerful g-range short wave broadcasting sta- in the world. The station is being gned to radiate the strongest signal sible to Europe, Africa and South erica, and the major transmitting ipment will include six 500 kilowatt, 250 kilowatt and six 50 kilowatt nsmitters. Some smaller transmitters modern receiving equipment will be included in the installations out- Greenville. Work at the site is go- to schedule, much of the timber, ch covered the area has been cleared roads and foundations for the build- are being constructed.

llas station

atest news on the new short-wave mercial station being built near las, Texas, is that construction is also gressing. When KFRN takes the shortly its programming has been ed as to reflect the cultural aspect of United States to its listeners in South erica in particular, but its powerful kilowatt voice should be heard around world. High gain antennas will be ployed to greatly increase its signal ngth and it is planned to commence ration on 15,180 Kc. The station is e on the air from 8.00 a.m. to 2.00 . with programs beamed towards th America. Programs will be in h English and Spanish, with emphasis the educational, and this private rt-wave broadcaster will present a l-balanced variety of education, news religious programs. Items such as cussions, news comments and inter- vs also will be carried, according to Crain, W5SXT, the President of Glo- Broadcasters at Dallas, Texas, U.S.A.

tican testing

EST broadcasts from Vatican Radio directed to listeners in the Philip- es, have been heard by one of our lers, Peter Barclay, of Balwyn, Vic- a. Peter reports best signals on 585 Kc., and weaker signals on 15,120 for the period of the test from 8.30 8.45 p.m. In the past Vatican has had much success in its services to area, and though this time of the does not favour signals from ope, the summer should provide lis- ers in this area, as well as the Philip- es, with a strong, clear transmission.

ngkok on 11,910 kc.

TER operating for several years on 15,385 Kc, the Radio Thailand over- transmissions have been recently d on the new frequency of 11,910 The station is best received during English period from 8.30 p.m., when news and weather is featured at the commencement of transmission. The complete schedule of the station is from 2.15 to 3.15 p.m. to North America in English, 7.30 to 8.20 p.m. programs for the Thai Forces in Korea and 8.25 to 9.57 p.m. the general overseas service. This includes English from 8.30 to 9.40 p.m., 9.30 to 9.45 p.m. in Malay, and 9.45 to 9.55 p.m. in Chinese. From 10 p.m. to midnight a relay of the home program is broadcast. This new frequency gives much better signals in this area, with freedom from jamming so prevalent on the 19-metre band channel.

English from Peru

A TRANSMISSION which includes a 30-minute program in English has been heard from "Radio America" in Lima in recent weeks. The session, "The Hour of Decision," featuring Dr Billy Graham, is heard on Saturdays from 10.00 p.m. to 10.30 p.m. on 6,000 Kc., with very good strength. "Radio America" opens at 9.00 p.m., and for one hour plays uninterrupted music, the odd break being for a few commercial announcements, but no identification is made to 10.30 p.m. at the conclusion of the English feature. Radio America in Lima uses OAX4V on 6,000 Kc and OAX4W on 9,405 Kc., during this transmission, and signals from both these stations can also be heard in the afternoon to 4.00 o'clock.

New Gautemalian signal

RECEPTION of the signals of "Radio Senora" in Guatemala City has been possible recently, when the signal has been heard on 6000 Kc mixed with "Radio America" in Lima. The station uses the callsign TGTA, and relays TGT on 1390 Kc. "Radio Senora" has a program of news at 3.00 p.m., and this concludes at 3.10 p.m., then follows a Sousa march and station identification. Following the details on the slogan and frequency TGTA concludes with a short portion of a marimba musical number, and closes at 3.15 p.m.

VLG9 on 9570 kc.

THE use of Radio Australia of 9630 Kc in its service to Asia has not been a success in the target area and the station moved the transmitter to 9570 Kc with the recent introduction of the Japanese Hour. On this frequency it is heard from 7.58 p.m. to 9.00 p.m. in Japanese, from 9.00 p.m. to 10.00 p.m. in English, on VLB11 11810 Kc and VLG9 9570 Kc. The transmission in English is continued on VLG9 to the end of the transmission at midnight. The Japanese program on Sundays at 8.47 p.m. includes the popular session, Australian DXers Calling, which is broadcast in Japanese for listeners in that area of the world.

Asian news

SOUTH VIETNAM regional station of VTVN has been observed in Japan using 9720 Kc. This transmitter is on the air from 8.00 to 11.00 p.m. with a program in Vietnamese.

CAMBODIA station in Phom Phen has been heard at good strength on 6092 Kc, with its foreign language broadcasts, which are found with some interference from VL16 in Sydney, using 6090 Kc. The station has a program in French from 10.15 to 11.00 p.m., 11.00-11.15 p.m. in Chinese, 11.15-11.30 p.m. in Cantonese, 11.30 to midnight in Vietnamese, midnight to 12.15 a.m. in Laosian, and 12.15-12.30 a.m. in Thai.

FLASHES FROM EVERYWHERE

MOROCCO is now using five different transmitters for its broadcasts and these range in power from 10 to 100 Kw, and so they are able to put 43 program hours on the air each day. These are in Arabic, Spanish, French and English, and the latter language is on the air at 4.15 a.m. on 11735 Kc.

TUNIS, which we are hearing well from opening on 6105 Kc at 3 p.m. in Arabic, is reported to be using other frequencies for this transmission. A Swiss report says that broadcasts at 3.00 to 9.00 a.m., the station uses 6200 and 6220 Kc. The Arabic program on 6105 heard from 3.00 to 4.00 p.m., and also 9.00 p.m. to midnight. At 4.00 p.m. it seems the frequency of 6105 Kc is altered to 6115 Kc to avoid interference.

TEHERAN, with its broadcasts in Persian, has been heard on the new frequency of 11715 Kc. The station broadcasts from 2.30 to 5.00 p.m. on this frequency.

ROME'S transmissions in English are at present well received in the afternoons, and the station is now operating on the following schedule. To North America, 10.30 to 10.50 a.m. and 1.05 to 1.25 p.m. on 9575 and 11905 Kc. To South Africa, 1.35 to 1.55 a.m. on 17800 and 21560 Kc. To United Kingdom from 4.20 to 4.40 a.m. on 6010 and 9575 Kc.

TAIPEH transmissions have been noted on 15225 Kc, which appear to replace the old 11815 Kc, for the transmission from 8.05 to 8.50 p.m., Bill Hawthorne, a Victorian listener, who first reported this change, lists the present frequencies as 17785, 15345, 15225 and 7230 Kc. The station is on the air in English for this transmission, which is beamed on the South Pacific, Japan and Korea, and carries the normal Taiwan programs of the Voice of Free China.

ADEN has increased its transmissions in the Aden Broadcasting Service, which is broadcasting only Arabic programs

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SOLDERING HEADS. Replacement bits in a range of designs are available.

VOLTAGE. Nominal rating for both models is 6-volt AC or DC. 5 volts to 8 volts provide a useful degree of heat control. Suitable step-down transformers for 240V AC of approved design are available from leading transformer manufacturers.

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ation is now on the air from 1.30 0 p.m., daily except Fridav and y, when the schedule is 4.30 to .m., also 10.00 p.m. to 7.00 a.m. using the frequency of 7170 Kc.

NCOUVER station CBUX, which the Canadian Broadcasting Cor- on station CBU, is reported in America to be heard from 5.15 5 p.m. daily on 6160 Kc. This 500-watt relay station has been on r for many years and, in a major of that time, used the callsign . Reception in this area is gener- poilt by the Far East Network in Tokyo, which uses the same el.

ITIAN station 4VEH has a new ot tower, and has installed a new watt short-wave and 5,000-watt m-wave station. The Bulletin programs, which gives news on Cap Haitian stations program, is heard on Sunday at 1.00 p.m., and ed on Monday at 8.45 p.m. on on 6002 Kc and 4VWI on 9773

otes from readers on their recep- of programs and transmissions ld be sent to Arthur Cushen, 212 Street, Invercargill, N.Z. All s are Australian Eastern Time.

ZANBIQUE regional stations have reported by a South African r. The station uses 9596 Kc from o 10.00 p.m., and on 4784 Kc 11.00 p.m. to 1.00 a.m., and from o 5.30 a.m. The other station on Kc is on the air from 5.00 to 7.30 nd switches to 4690 Kc from 2.30 0 a.m. Another relay station in ern Mozambique is reported to be e air, and the Radio Club of nbique says a station operates in ea in the 31 and 60-metre bands. small regional stations have their programs, but news bulletins and material is relayed at times from y station in Lourenco Marques.

NILA transmissions of the Far Broadcasting Service have been on the new frequency of 7250 Kc. FEBC transmitter appears to be on as an experimental outlet, as the ncy is not mentioned. It has been from 2.30 to 4:00 a.m., with the l gospel sessions.

ZANZIBAR is reported by a South African listener to Radio Australia as being heard on the new frequency of 6005 Kc. The station has been noted from 11.30 p.m., but from a weak signal it improved with a B.B.C. relay at 1.45 a.m. The station was heard to close at 2.30 a.m. English identification was given. Western discs are frequently heard and the program is mainly of request numbers for listeners in Tanganyika, 45 miles away from Zanzibar Island on the mainland of Africa.

MADRID which carries the programs of the Spanish National Radio for its listeners overseas (as carried on its own home service), has now been reported as using 6005 Kc, after tests on several other frequencies in the 49-metre band. The station has been heard from 6 p.m. to sign off at 11 a.m. the following day.

GABON has been heard in Europe with test transmissions in French. The signals are received on 4775 Kc, and the program in French is from 3.30 to 7 a.m. Transmissions indicate they are of an experimental nature.

BENGHAZI in Lybia has been reported frequently on 9895 Kc, and it now appears that a transmission from 3 to 4 p.m. is carried on this channel, while the evening service, which we can hear from 2.30 to 7.15 a.m. is also carried on 3305 Kc.

TUNIS is carrying a transmission to the Middle East on the new outlet of 17905 Kc and this service in Arabic from 3.15 to 4 a.m.

LEOPOLDVILLE on its broadcasts for European speaking listeners in the Congo is now using three frequencies to carry this service, it being heard on 4760, 6295 and 9380 Kc. Though signals can be tuned at 4.15 a.m., when news in French is carried, best reception is now at 6.50 a.m., again with news in French. At 6.55 a.m. news is in Flemish and the station leaves the air at 7 a.m.

DELHI with the broadcasts of All India Radio to Europe has again switched its frequencies for this transmission, which is on the air from 5.45 to 6.45 a.m., and the programs are now released on 11705 and 9720 Kc to Europe and on 11805 and 17790 Kc, with the beam on West Africa.

LATE NEWS IN BRIEF

ERIAN station ELWA has been with transmissions to the Congo nch and native tongues from 2 to . The signal has been tuned on ew frequency of 15080 Kc by American listeners.

PEH has taken the use of 11735 or its transmission in English, takes the air to the South Pacific p.m. This program is on 15345 785 Kc, and seems to have drop- 30 and 15220 Kc. The program glish news at 8.15 p.m. and from 9.20 p.m. is in Japanese.

ZZAVILLE has added the 13 frequency of 21500 Kc for the in the afternoon, which is heard .30 p.m. to 5.30 p.m. The broad- also on 15455, 11730 and 9730 th English news at 3.15 p.m. has been heard by August Balbi Angeles with tests from Accra on 7130, 9545 and 11740 Kc during the afternoons. The announcements were in French and English.

NORTH BORNEO with the transmissions of Radio Sabah in Jesselton is reported to be using 5980 Kc as well as 4970 Kc., which we mention on this page. The signal on 5980 Kc. has been heard to sign off at midnight.

CONGO broadcasts from Brazzaville to the North American listener has been noted on the old frequency of 11970 Kc. The station is heard with the broadcast on the air from 8 a.m. to 12.30 p.m., and has English news at 11.15 a.m. 12.15 p.m.

SUDAN has been noted to sign off at 8.19 a.m. on 7200 Kc with the broadcast in Arabic from Khartoum. The station has also been noted on this frequency from opening the transmission for the day at 2.15 p.m.

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ANSWERS TO CORRESPONDENTS

R.G.L. (Richmond, Vic.) is proposing to obtain his amateur licence and to operate from a sea-going yacht. He wants to know whether fully transistorised equipment would be available and what power would be required.

A.: We suggest that you are confusing things a little, R.G.L., since the requirements aboard ship and the functions of the amateur are somewhat different. There would be no objection to operating amateur equipment under such conditions, but normal commercial traffic would require approved equipment operating on internationally agreed ship frequencies. It may be possible to obtain fully transistorised equipment for these and some amateur frequencies, and we suggest you contact commercial firms specialising in such installations. The power allowed for amateur work is set down in the regulations, but lower values can be used successfully in favourable circumstances. In general, we feel that, by the time you are ready to take your A.O.C.P. exam., you will be able to answer most of these questions yourself. However, it should be pointed out that a purely commercial installation on board ship, if of approved type, normally would require much less in the way of technical qualifications in order to be granted a licence.

G.M.S. (Bendigo, Vic.) wants to know if we can identify a vibrator cartridge, and also explain a "tinkling" sound he has noticed which occurs in some battery valves when the set is switched off.

A.: The vibrator V4016 is a 12-volt non-synchronous type manufactured by Manufacturers Special Products, 47 York Street, Sydney. It is similar to the Ferrocart type 338. We suggest you contact the makers for further details. We have never noticed, in battery valves, the noise to which you refer, and we imagine it may be a freakish condition peculiar to the one particular valve. In any case we doubt if the condition need cause any worry, particularly as the set appears to be performing well in all other respects. It is probably caused by movement of a support mica against the glass envelope as the valve heats or cools. Or it may be a filament spring moving against a mica, with the latter transferring the noise to the glass.

I.S.J. (Noble Park, Vic.) writes to express his appreciation of the indexes published in the recent issues, and to inquire about some he cannot trace. He also draws our attention to a capacitance meter described in a recent overseas magazine.

A.: Many thanks for the comment, I.S.J., and we hope to catch up on this situation just as rapidly as time and space permits. We are not quite sure how the confusion arose concerning volume 8, but you should have been advised more accurately. We will certainly investigate the article you mention, and the possibility that it may be of local interest.

Our thanks also for your kind expression of sympathy, which is much appreciated.

A.V. (Crafers, S.A.) sends us brief details of a broadcast tuner which he has developed, and offers some criticism of the symbols used to represent various units of electrical and mechanical quantities in books and other publications.

A.: Many thanks for the details of the tuner, A.V., which we read with interest. Frankly, however, we feel that some of the points you mention are debatable either as facts or by the degree of importance, which you attach to them.

Regarding the representation of units in publishing matter, we agree with you in the criticism that the symbols used vary widely. However, in the case of many units the accepted symbol is a Greek letter (such as the use of "mu" to represent micro), which present difficulties for publications which are set up on newspaper type linotype machines. It thus becomes necessary to substitute either Anglicised abbreviations (such as mfd. standing for micro-farad) or a normal letter which is closest to the Greek symbol (such as uF.). Thus arises the confusion, since various people and organisations standardise on differing methods of representation.

W.M. (Maidstone, Vic.) is worried about the voltages in a cathode-ray oscilloscope. Since the EHT positive is usually earthed to the chassis, he wants to know why this voltage does not affect the cathodes of the amplifier valves, which also return to chassis.

A.: What you have failed to appreciate is that voltage is really an elect
pressure which exists between spe
points. As far as the amplifier va
are concerned, the only voltages ap
between their various electrodes c
from the normal HT supply, whic
limited to about 350 volts. It so
pens that the negative side of this
ply is connected to chassis, so tha
voltages across the valve electrodes
be positive with respect to chassis,
normally less than 350 volts.

The EHT supply may produce so
thing like 1,500 volts and, for techn
reasons, it is usual to return the pos
side to chassis. This means that all
tentials derived from the EHT supply
negative with respect to chassis, b
applied across the cathode-ray tube
its relevant circuitry. But there is
path by which this large EHT vol
can appear across any of the circui
do with the amplifier valves; there
they are in no way affected by
presence of the EHT circuit.

A.S. (Busselton, W.A.) asks us if
would publish details of an electr
flash unit and other photographic e
ment in forthcoming issues of the m
zine.

A.: We did publish details of
tronic flash units in the past, A.S.,
as in the April, May, June and Oct
1954, issues. We have no imme
plans for further units of this type,
we will bear your suggestions in
for possible future use in the maga

RADIO, TELEVISION AND HOBBIES QUERY SERVIC

TO assist our readers, "Radio, Television and Hobbies" conducts a technic
query service. Conditions governing this service are set out below:—

(1) Requests for copies of circuits or technical queries requiring
answer through the post must be accompanied by postal note or stamps to t
value of TWO SHILLINGS. Queries not accompanied by a fee will
answered in rotation on these pages.

(2) For the 2/ fee, we will supply circuit data, as available, for up
three projects. The amount of data available varies, but in no case can
include information additional to that already published in the magazin
As a rule, requests for circuits will be answered more speedily if they a
clearly identified and not complicated by questions requiring the attenti
of technical personnel.

(3) The technical query service is aimed primarily at assisting reade
in matters relating directly to articles published in the magazine. Answe
will be given in note form and only so far as can be drawn from gener
knowledge of the relevant subject. We cannot provide lengthy answers, unde
take special research, discuss commercial designs or draw special circuits.

(4) The Editor reserves the right to return query fees or to limit t
scope of an individual reply, where it is felt that a partial answer will
better than none at all. Please note that the inclusion of an extra fee do
NOT entitle correspondents to special consideration.

(5) In addition to the normal query service, chassis blueprints are ava
able for most of our projects, showing the position of all holes and cuto
for metal-working but containing no details of wiring, etc. Apart from co
plicated projects like TV sets and oscilloscopes, most blueprints cost 5/ eac
Original photographs of most projects are also available, from 5/ for a 6
x 8in glossy print; postage 9d extra.

(6) Letters should be addressed to the Technical Editor, "Radio, Te
vision and Hobbies," Box 2728, G.P.O., Sydney.

(7) "Radio, Television and Hobbies" does not deal in radio compone
nor will we debate the relative merits of competitive products. Prices a
specifications of merchandise must be obtained from our advertisers.

(8) Technical queries are not answered by telephone.

.W.O. (Oatley, N.S.W.)** sends us a r with some comment on the Wide d Audio Oscillator described in the il, 1960, issue. He suggests that the ge feedback capacitor, which is given 0 uF., is too big and that an 8 uF. ld be adequate. This is worthwhile, tates, from the point of view of space d and of economy. B.W.O. also ests a method of supporting resistors d the wafer on a switch bank. This ses an extra wafer, on spacers, but connected to the switch proper by centre shaft. The resistors are then orted drum fashion round the two rs.

.: The input impedance of the bridge t low frequencies, very nearly equal th and Rk in series, since the R/C ion will have quite a high imped- . Therefore Cb will need to have reactance compared to the bridge dance in order to avoid loss at low uencies. Since we were expecting the lator to produce frequencies as low 8 c/s we considered 40 or 50 uF. e a minimum. The oscillator would ubtedly work with an 8 uF., but ould not be the best choice. In case the difference in price is only t 1/6.

ne method of mounting the resis- is often used in commercial equip- , but, as we did not experience n difficulty with our switch wiring, lid not consider it necesary in this It is a good idea, however.

.C.G. (Coburg, Vic.) sends us the it of a TV tuner he has designed suggests it may be of use to other ers. He also suggests that we pub- a series of handbooks to help begin- reach the technical standard of our advanced readers.

: Many thanks for the circuit and estions, M.C.G. It is not clear from letter whether you have actually the tuner or merely worked out circuit. In any case results and rage would depend on details of lay- nd coil data. We agree that your suggestion may have some merit, ugh, unfortunately, the preparation andbooks takes a good deal more than might be imagined. In addi- we feel that the provision of regu- eginners' projects has the advantage they can be designed to suit com- nts currently available.

R.H. (Chrischurch, N.Z.) sends us s of a two transistor set which he up, incorporating an emitter fol- stage to reduce loading on the circuit.

Many thanks for the circuit and s, P.R.H., which we read with in- . We notice that your circuit does nclude regeneration. The inclusion generation in a transistor set (par- rly) reduces the loading of the circuit by the transistor input im- nce. Thus the normal practice is e regeneration together with the on emitter circuit. The regenera- thus increases both the sensitivity he selectivity.

V.U. (Alectown, N.S.W.) sends us scription to the magazine and sug- that he would like to see more ur articles.

Many thanks for the subscription, J., which has been forwarded to ppropriate department. Our appre- also for your comments and suggestions, and we will certainly keep these in mind. We are hoping to increase the number of amateur articles, but, just at the moment, circumstances seem to be against them.

P.H. (Mortdale, Sydney) says that he has just installed a second-hand car radio in his 1948 Ford V8. He has connected a 15,000 ohm resistor in the main H.T. lead, but still has trouble with ignition noise.

A.: If we remember correctly, the H.T. leads, together with the L.T. lead to the distributor, were run inside a tube mounted on the block between the heads. It sometimes helps if the L.T. lead is removed and taped to the outside of this tube in order to minimise hash pickup in the L.T. wiring. Apart from this, only standard interference suppression methods can be recommended. Some of these were discussed in the December, 1956, issue, as a follow up to the 1956 Car Set articles.

I.A. (Snt. Georges, S.A.) writes to tell us of his success in the January AOCP examinations and of some of his experiences on 288 mc/s. His success, he says, is entirely due to the "Getting Your Amateur Licence" series, which we ran some time ago.

He has found that some of the generally recommended textbooks are a bit too complex for exam. purposes and that our series was just sufficiently detailed, yet simple enough for exam. conditions.

A.: Thank you for your kind remarks about the course. We will keep in mind your suggestion about providing the contents of the series in the form of a pamphlet. We feel that there is a definite need for this type of material to help budding amateurs.

Also thank you for your sympathetic words on the passing of Mr Moyle.

R.G. (Toowoomba, Qld.) asks for diagrams of short-wave receivers and 10-watt amplifiers.

A.: Sorry, R.G., but we cannot accede to a request in quite these terms. We have described many short-wave receivers and quite a few amplifiers in the 10-watt class and it would be impractical to collect circuits of them all. It would be essential to be more specific in both cases. Large receivers or small receivers? Amateur only or general coverage? Public address type amplifiers or gramo. amplifiers? If the latter, single unit or of the two-unit variety? For magnetic or crystal pickups?

A further point is that you have enclosed no money to pay for these circuits. The terms are set out in the accompanying panel.

H.T. (Malaya) sends us details of a corrected version of the stereo balance indicator published in March, 1960.

A.: Thanks, H.T., the circuit was definitely wrong as published. We agree that the circuit can be corrected by reversing the polarity of the right-hand diode, and we will publish a corrected version of the circuit in due course.

A.S. (Samaria, Vic.) writes to tell us of the very good results he has had with a one-valve set, and asks if we have any details of a "frame aerial."

A.: Many thanks for your letter, A.S., and the report on the one-valve set. The list of stations is certainly impressive, but results like this are not unusual with a well-adjusted and well-handled regenerative set. In regard to the frame aerial we refer you to the Reinartz Portable in March, 1953.

MICROMINIATURISATION

(Continued from Page 5)

microcircuits and solid circuits have fewer interconnections, which may give them increased reliability. Solid circuits have the largest packing density, but, to counteract this advantage, they have the drawback of being very sensitive to temperature. There are many other considerations to take into account and, all in all, it is likely that the three systems will be developed in parallel for a long time.

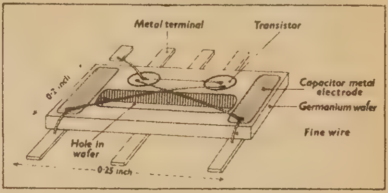

Fig. 3. An example of the solid circuit. This is a square wave generator built on a germanium bar measuring only .1in x .2in x .25in.

It is interesting to compare the number of components that can be packed in a given space by using microminiaturisation as compared with other electronics constructional techniques. The approximate average number of components per cubic inch is given in Table I.

There are no figures available on the reliability of microminiaturised systems, because the developments are still in their infancy. Work on micromodules began in 1958, and not enough time has elapsed since then to subject the completed units to long life tests of many thousands of hours. However, for a variety of reasons, it is expected that the reliability of microminiaturised circuits will be at least equal to, and probably much better than, that of circuits made by conventional techniques.

TABLE I

Method of construction	*Number of components per cubic inch*
Normal valve	1
Miniature valve	4
Sub-miniature valve	7
Normal transistor	20
Transistors with sub-miniature components	30
Micromodule	300
Microcircuit	1,500
Solid circuit	20,000

Microminiaturisation is suitable for low and medium power circuitry. Already several kinds of micromodules are available commercially, including amplifier stages, oscillators, digital circuits, etc., and there is a strong possibility that before long the circuit designer will use microminiaturised circuit stages as the building blocks of his electronic equipment, just as he now treats an individual component. So striking is the increase in packing density obtained with microminiaturisation techniques that, provided the reliability is maintained, this new form of circuit engineering will find a permanent place in electronics. (From "The New Scientist.")

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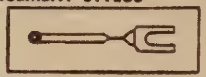

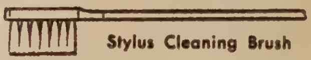

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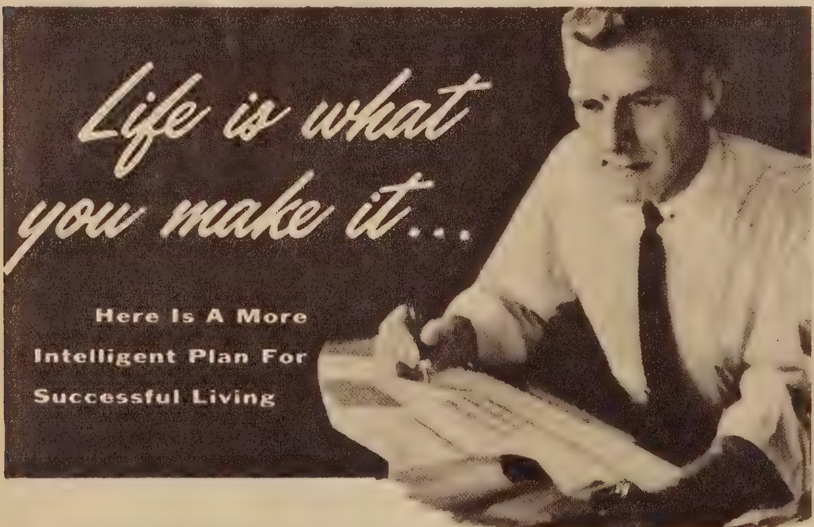

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SENSITIVE TV CAMERA TUBE

IEW low-light-level image orthicon, nade by General Electric, has won eted Emmy award for technical ad- in colour TV.

Academy of Television Arts and es cites the new, supersensitive for "permitting colourcasting in no light than is needed for black-and-" A committee of television en-s and technicians, who are mem-of the academy, made the nomin-

ter known to technicians in the ndustry as the GL-7629, General ic's revolutionary "see-in-the-dark" a tube has gone places and done , especially in colour TV, but also ck-and-white, that previously were sible.

erating at light levels 10 times lower he minimum required by standard cast image orthicons, the new tube vept aside technical problems which y limited colourcasting to specially ped studios under bright, even and lly controlled lighting.

h the GL-7629, high-quality colour lack-and-white pictures can be pro- almost anywhere, indoors or out, r night, with only the available or, in some cases, with nominal lighting.

ce its introduction, the new tube nade a number of historic telecasts our and in black-and-white.

A VACANCY ON OUR TECHNICAL STAFF

We have an immediate vacancy on the staff of "Radio, Television and Hobbies" for a radio engineer or an experienced technician capable of originating, constructing and describing the class of project regularly featured in these columns.

Academic qualifications and the A.O.C.P. are an advantage but not essential for the position. More than anything, we are keen to find someone who has had experience in the varied fields of audio, radio and television and transmission and who wants to extend and capitalise upon it as a technical journalist.

Applicants should be resident in Sydney and free to begin duties within one month of appointment.

Applications should be made, in the first instance, by letter only, giving details of experience, copies of references and stating the order of salary required. Letters should be addressed to The Technical Editor, "Radio, Television and Hobbies," Box 2728C G.P.O., Sydney.

All correspondence will be treated with the strictest confidence.

Upon appointment and subject to satisfaction and medical examination, the successful applicant will be eligible for four weeks annual leave, Accident and Sickness benefits and Superannuation.

LET'S BUY AN ARGUMENT

(Continued from Page 95)

to establish a figure for the valve's transconductance for the plate current at which you propose to use it.

This can often be obtained from valve curves of transconductance v. plate current.

Work out the parallel resultant of the plate load resistor, following grid resistor and valve plate resistance. In the case of a triode, this latter should be deduced from the slope of the plate curves at the approximate plate current level.

Then multiply effective transconductance by the parallel resultant, as above. Incidentally, if the transconductance is expressed in mA/V and the resistance in ohms, don't forget to divide by 1,000 to make the quantities conform.

Multiplying micromhos by megohms will give the same answer.

Of course, if this seems too difficult, you can often work out gain by graphical means or, more simply, consult tables of R/C data given in most valve handbooks.

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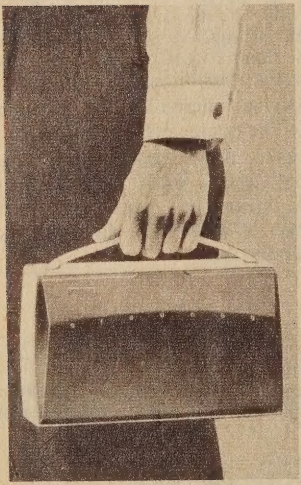

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YSTERY OF LIFE

(Continued from Page 19)

d negotiate the track without error. ccording to Dr Smith, "the machine ied far better than any man or ial, for no living organism can be nded on to make no errors of this after only one trial."

or those interested it can be said that machine is provided with a rudder l in the track and a motor. A "mem- disc" is provided with as many es as there are blind alley forks. hen the trolley hits a dead end the r is reversed and one flange on the is depressed. This causes a rocker to fall into a hole which in turn s one electrical contact and breaks ier. This connects one solenoid and nnects its opposite. These solenoids ol the steering or rudder wheel.

a system of levers the "memory is turned to the appropriate flange so the machine is progressively set, s finally conditioned to take a dir- ourse.

LOV'S EXPERIMENTS

the turn of the century a Russian ist Ivan Pavlov carried out some iments on the nature of the di- n of dogs. It is a well-known phe- non that, when a dog sees food, it s a copious flow of saliva.

vlov's method illustrates just to lengths some fellows will go to a point. He connected a rubber to the salivary gland of a dog. flowed down this tube on to a te platform resting on a spring. h drop of saliva falling on the rm caused a mark to be made on lving drum. It was then possible to l not only the number of drops ie exact moment when they fell.

vas also possible to state not only mount of saliva secreted in ten l intervals but the total amount was collected from the platform h half minute.

results of this and other experi- was facetiously called the "sci- of slobbering." Pavlov also made interesting observations which he conditioning.

instance if a bell was rung at the time as the offering of food and as continued for a little while, g became conditioned to the bell He would slobber when the bell ing even if there was no food. ov found that after a while the ould get a bit tired of having no hen the bell was rung and would to respond to the bell unless he conditioned as before. This was "experimental extinction."

ICIAL VERSION

in 1929 a chappie named R. G. r in America devised a thing can be called an artificial slobber- was a simple affair worked with orage batteries, two switches and . We illustrate the device here r information. We will call switch od", Switch B "bell," and the dog."

u will follow the diagram it will that if switch A is closed while B is open, current will flow from rged battery via the switch and np will glow. This corresponds lobbering of the dog at the sight d.

Now close switch B with switch A open. The lamp does not glow. This corresponds to the dog's first indifference to the bell. Now close both switches together and hold them for a few seconds. Current flows from the charged battery into the uncharged battery. Now close switch B only and the lamp will glow.

Switch B has become conditioned to switch A corresponding to the dog's response to the bell alone. After repeated switching of switch B the battery runs down and the lamp will not light. The dog is tired of the bell and suffers experimental extinction.

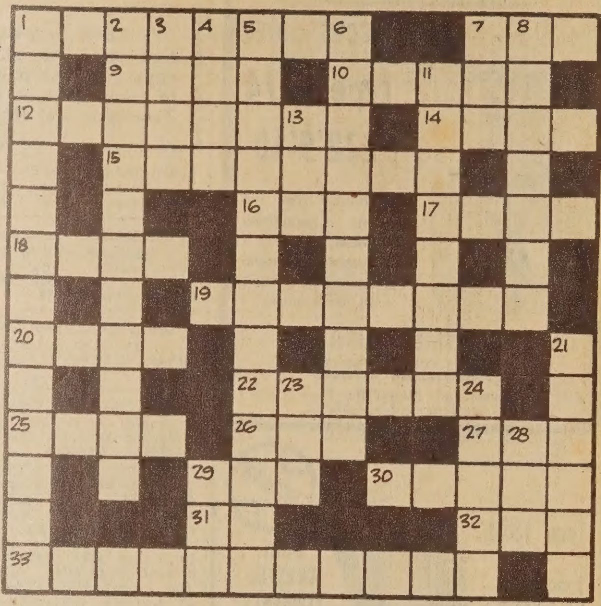
If both switches A and B are again pressed together we again condition the dog to food and bell and bell (switch B) can again be pressed when the dog will again respond.

DEVELOPMENT

Krueger developed his apparatus in such a way that a whole series of circuits could be conditioned to each other such as, after conditioning switch B to A, he could condition C to D and so on. This provided a series of reactions similar to Pavlov's experiments where, after conditioning a bell to the food, he conditioned a flash of light to the bell then a luminous disc to the flash of light.

Many other types of "thinking machines" have been devised to simulate the behaviour of man. Today we have intricate machines which can carry out many operations previously performed by man, but man still has to set the machines.

THE R., TV & H. CROSSWORD No. 76



ACROSS

1. Transfer of signal energy from output to input of the same system.
7. Reduce friction.
9. One untrustworthy
10. The power absorbed and used in an electrical device.
12. It varies the resistance.
14. By the mouth.
15. Types of plants.
16. Large expanse.
17. The rainbow.
18. Broadcasts.
19. They can be depended upon to do a holdup job.
20. Ages.
22. Vessel.
25. More than one focus.
26. Fall ill.
27. Erode.
29. Consumed.
30. Visible line made by the electron beam on a picture tube.
31. The (Fr.).
32. Lair.
33. It goes up and down.

DOWN

1. Rotation of a beam of polarised light passing through a magnetic field (2 words).
2. The science dealing with the action and effects of electron flow in vacuums and gases.
3. Famous designer.
4. Foundation.
5. Important in the outback (2 words).
6. One way of receiving signals.
7. Pronoun.
8. They lean to the right.
11. Are you certain you know this terminal?
13. Emulate.
21. It protects the man with the ideas.
23. Hurry.
24. English novelist.
28. Card.
29. Drink.

Last month's solution

F	E	E	D	B	A	C	K	■	■	O	I	L
A	■	L	I	A	R	■	I	N	P	U	T	■
R	H	E	O	S	T	A	T	■	O	R	A	L
A	■	C	R	E	E	P	E	R	S	■	L	■
D	■	T	■	■	S	E	A	■	I	R	I	S
A	I	R	S	■	I	■	E	■	T	■	C	■
Y	■	O	■	H	A	I	R	P	I	N	S	■
E	O	N	S	■	N	■	I	■	V	■	■	P
F	■	I	■	■	W	H	A	L	E	R	■	A
F	O	C	I	■	A	I	L	■	■	E	A	T
E	■	S	■	A	T	E	■	T	R	A	C	E
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17/8 ips TAPE

(Continued from Page 77)

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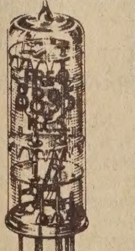

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